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Provo Equalizing and Storage Reservoir

Drought forces storage of limited spring-water supply in a five-million-gallon covered reservoir—Soft spots in foundation changed floor design—Metal-shield expansion joints and mopped waterproofing prevent leaks

By C. J. Ullrich
Kimball & Ullrich, Consulting Engineers, Salt Lake City, Utah

METHODS of determining required reservoir-storage capacity, foundation problems, novel methods of placing concrete in the walls and waterproofing provisions distinguish a new 5,000,000-gal. reinforced-concrete circular reservoir recently built to equalize the spring-water supply of Provo, Utah. The springs supplying this city of 15,000 people emerge from the mountainside in Provo Canyon over a distance of several miles. A pipe system collects the water, which is conveyed 25,000 ft. in a 21-in. wood-stave pressure pipe and a 27x30-in. concrete conduit to a regulating house where, prior to the building of the reservoir, the water was turned directly into a 20-in. and a 12-in. pressure main leading to the city. Surplus water was wasted into an irrigation ditch.

The drought in the spring and early summer of 1930 reduced the daily flow of the springs by 2 m.g.d., causing a shortage at the peak demand of the day. While the actual consumption for the 24-hour period was still below the total flow for the same period, the maximum rate of consumption exceeded the rate of flow of the springs by 350,000 gal. per day. The rate of consumption in a 24-hour period varied during June, 1930, from 1.5 m.g.d. minimum to 4.3 m.g.d maximum, with an actual consumption of 3.2 m.g.d. It was evident that the immediate storage capacity required for equalizing purposes was 350,000 gal.

Size Determination — To determine more fully the proper size of reservoir, an economic survey was made, taking account of the water supply available, the acquisition of additional supplies, peak demands, equalization storage, holdover storage for emergencies and fire protection, future growth of city and unit cost per 1,000 gal. of storage. With all these conditions taken into consideration, a reservoir of 5-m.g.d. capacity was recommended and adopted by the city commission.

As built, the Provo reservoir is 206 ft. in diameter and 21 ft. deep, completely buried and covered with 18 in. of soil. Where the reservoir wall projected above the natural surface of the ground it was backed with an embankment 12 ft. wide on top, with an outer slope of 1 to 1.

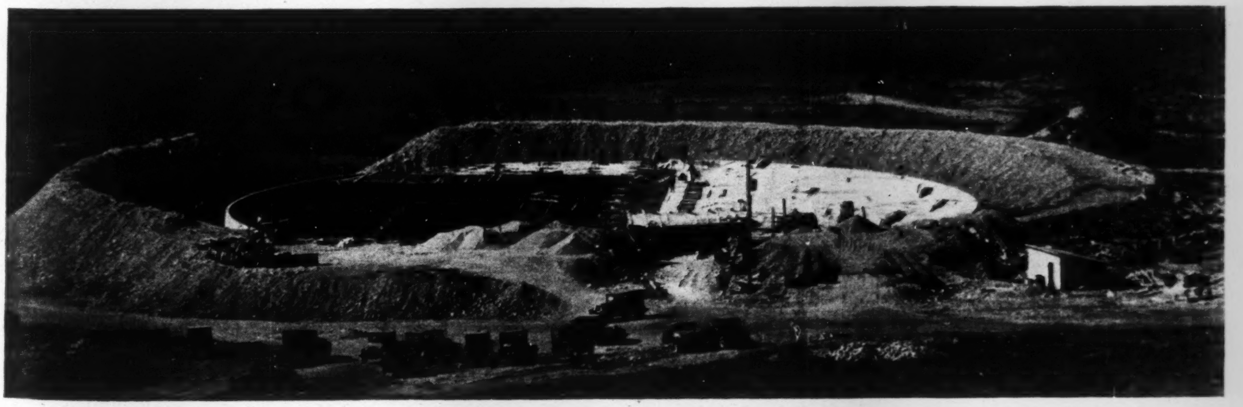

Fig. 1—Constructing a 5,000,000-gal. reservoir to store mountain spring water for Provo, Utah.

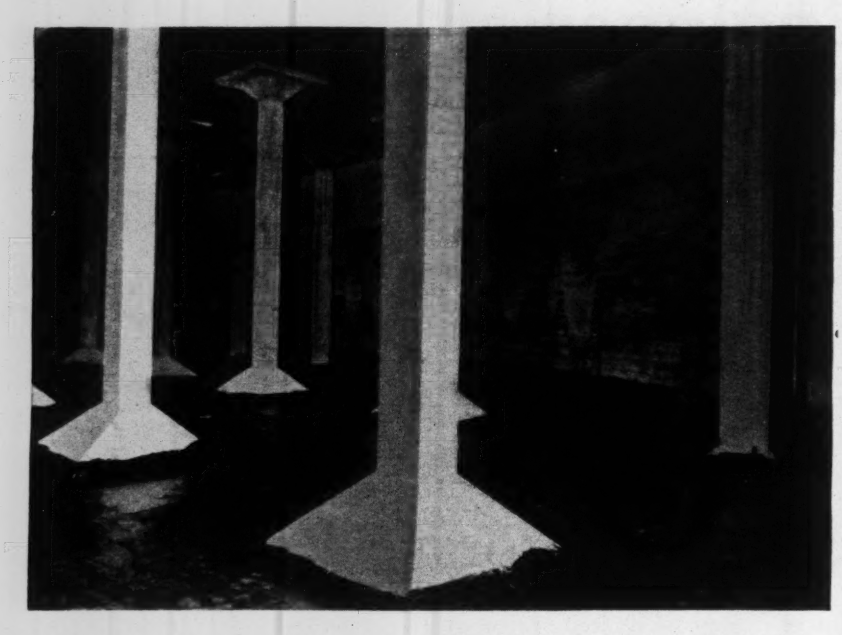

Fig. 2—Mopped fabric covered the floor and was lapped a short distance up wall and column footings.

Design Factors—The circular wall of the reservoir was designed as a cantilever. Account was taken of that part of the roof slab transmitting its load directly onto the top of the wall, but no account was taken of the added stability secured by reason of the wall curvature or the load superimposed on the inner footing by the columns. The maximum soil pressure at the outer edge of the footing is 2,270 lb. per sq.ft. The roof is of the flat-slab, drop-panel type, designed in accordance with the New York building code as published in *Engineering News-Record,* Aug. 12, 1920, p. 300. Loading included 4 ft. of snow.

No entrances were allowed through the reservoir wall. All pipes leading into the reservoir were brought through the floor. Special treatment was applied around each pipe to insure a watertight joint.

Soft Spots—Two test pits, 25 and 27 ft. deep, sunk near the reservoir site, showed uniform material for their entire depth—sand, gravel, boulders and broken slabs of sandrock, all deposited as a mountain wash material. The bearing power of this material was estimated at 3 tons per square foot. However, in excavating the reservoir pit several areas of clay were encountered near the floor grade, to a depth of 6 ft.; the steam shovel came near turning over when it unexpectedly encountered one of these pockets. Although these soft spots dried out quite rapidly when exposed to the air, all of them, involving 1,132 cu.yd., were dug out and refilled with sand, gravel and boulders, compacted with a 10-ton roller. After excavating the reservoir pit to grade the entire foundation site was rolled with a 10-ton roller, disclosing an additional spot below the foundation grade.

Drains—As an extra precaution, four 6-in. tile drains, each 6 ft. below floor grade, were installed under the entire reservoir foundation. Two of these

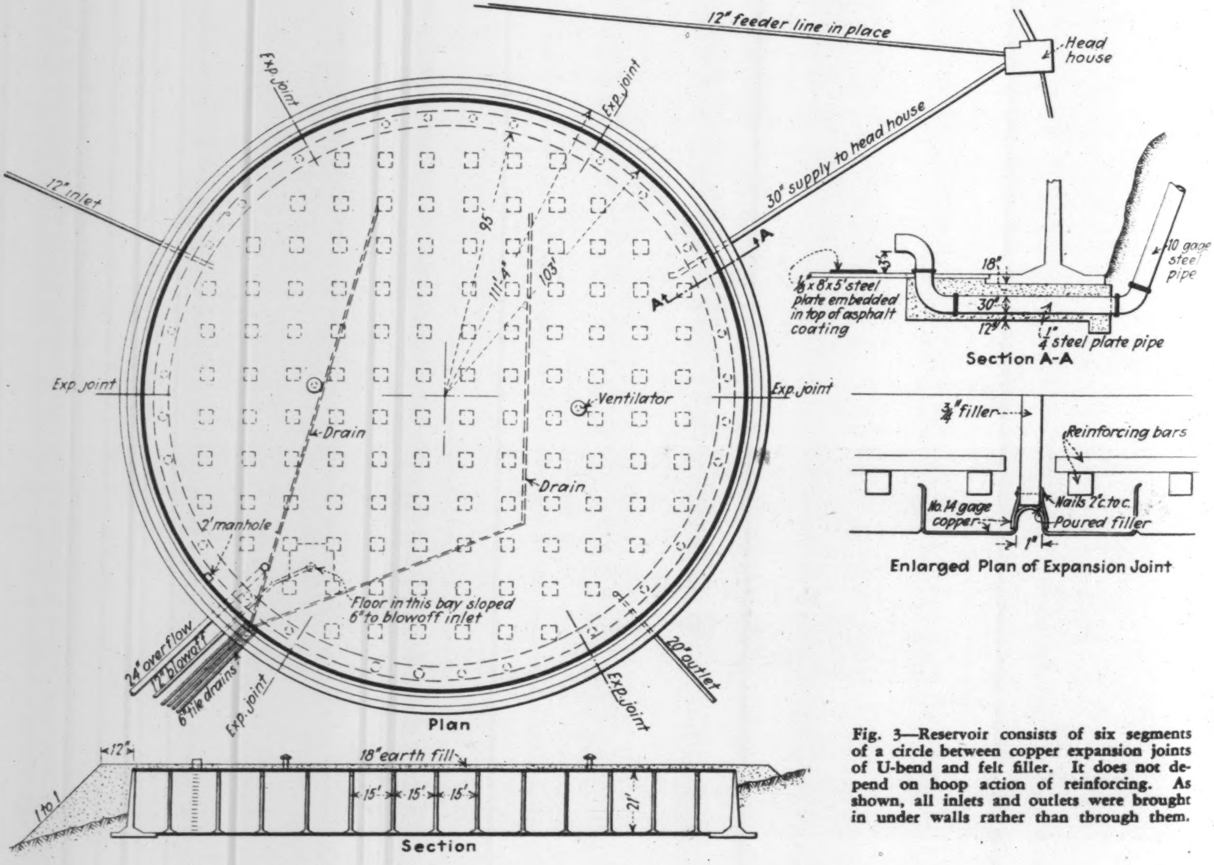
12" feeder line in place
Head house
30" supply to head house
12" inlet
Exp. joint
Exp. joint
Exp. joint
Exp. joint
Exp. joint
Exp. joint
95'
111'-4"
103'
A
A
Ventilator
Drain
Drain
2' manhole
Floor in this bay sloped 6" to blowoff inlet
24" overflow
12" blowoff
6" tile drains
20" outlet
Plan
12"
18" earth fill
15'
15'
15'
21'
1 to 1
Section
$\frac{1}{8}$" x 8' x 5' steel plate embedded in top of asphalt coating
18"
30"
12"
10 gage steel pipe
$\frac{1}{4}$" steel plate pipe
Section A-A
$\frac{3}{4}$" filler
Reinforcing bars
No. 14 gage copper
Nails 2" c. to c.
Poured filler
1"
Enlarged Plan of Expansion Joint

Fig. 3—Reservoir consists of six segments of a circle between copper expansion joints of U-bend and felt filler. It does not depend on hoop action of reinforcing. As shown, all inlets and outlets were brought in under walls rather than through them.

drains, with separate outlets, were located under the center of the wall footing, each extending around one-half of the circumference. The other two drains extended across the floor foundation and also terminated in separate outlets. The reason for giving each drain a separate outlet was to determine more precisely the location of any leakage in the reservoir after it was put in service. No soft spots were encountered in excavating for the tile drains, but in backfilling the trenches all material was compacted to place.

Originally the footings for the roof columns were designed independent of the floor system, with special watertight joints where the floor abutted the column footings. After the soft spots were encountered in the reservoir foundation it was deemed advisable to change the type of floor to a reinforced-concrete mat, with the column footings resting on top of the floor. This mat was treated as an inverted flat slab, like the roof.

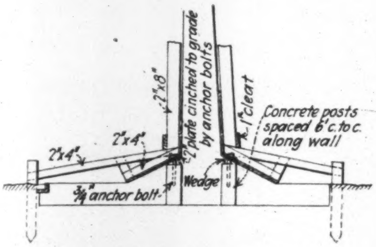
2"x8"
2" plate cinched to grade by anchor bolts
1" cleat
Concrete posts spaced 6' c. to c. along wall
2"x4"
2"x4"
¾" anchor bolt
Wedge

Fig. 4—Forms for transition section at base of wall.

Expansion Joints — Six expansion joints of the exposed-metal-shield type were provided in the walls and wall footing. This type of joint consists of a 14-gage copper shield with U-bend 1 in. wide and 1 in. deep in the center. The sides are bent at right angles for a depth of 1⅞ in. to enter the concrete wall. The metal shield is backed up with a ¾-in. preformed bituminous filler of dimensions similar to the cross-section of the wall and footing. Each joint was fabricated and welded together at the turns, so that when set in place it conformed exactly to the inner surface of the wall and footing. After the concrete for the wall was deposited against both sides of the expansion joint, petrolastic asphalt heated to 350 deg. F. was poured into the space between the metal and the filler.

Waterproofing — The reservoir floor was waterproofed in the following manner: First, the entire floor was thoroughly cleaned and dried. Next a coat of asphalt primer, 1 gal. per square, was applied, followed by a heavy mopping of petrolastic asphalt, to which, while hot, was applied a layer of standard waterproofing fabric. On the waterproofing fabric was mopped hot petrolastic asphalt. Over the expansion joint at the intersection of the reservoir-wall footing and floor an extra ply of standard waterproofing fabric was mopped on with hot petrolastic asphalt. At each column the waterproofing was carried well up the column footings. The specifications called for at least 85 lb. of petrolastic asphalt per square in the finished waterproofing surface. The circular wall of the reservoir was treated with a coat of boiled linseed oil, applied at a temperature of 125 deg. F. The roof was first given a coat of asphalt primer and then mopped with 30 lb. per square of hot petrolastic asphalt.

Construction — The specifications required that parts of the reservoir wall and wall footing betwen two consecutive expansion joints be built monolithic. No wire ties were allowed to pass through the forms. To support the wall forms, the contractor built concrete piers, 10 in. square and 6 ft. apart, along the inner and outer circumference of the wall proper, so set that the inside face of each pier came flush with one face of the wall and to a height even with the base of the wall proper. In the top of each pier a ¾-in. anchor bolt was set. The wall forms were built in sections with a 2-in. plate at the bottom, cut to the curvature of the wall and set to the proper bevel. Holes were drilled through the plate for the anchor bolts, and the form was set on top of the piers, cinching it to place by means of the anchor bolts and steel wedges inserted between the upper edge of the plate and the top of each pier. The top of the wall forms was held in position by bracing to a runway extending around the outside of the wall. The piers were held firmly in place by reason of the reinforcement in the wall footing passing through them. After the forms were removed the holes left by the spreaders were plastered up to prevent leakage.

In depositing the concrete the wall footing was first placed, starting at one end and continuing to the other end of the section, smoothing off the top of the concrete on that part of the footing exposed as the concreting progressed. After the footing section was deposited the forms for the transition section were placed. The forms were set in place by slipping the 2x4-in. braces under the cleat nailed to the wall studding and on top of the wall plate, and fastening the other end of the braces to stakes driven into the ground at the edge of the footing. The concrete was spouted from the top of the wall into the transition section, starting at the same end that concreting for the footing was started. By progressing in this manner the footing concrete had set sufficiently so that the weight placed on top of it did not cause any bulging at the top of the concrete in the exposed portion of the footing. After the concrete for the transition section was in place the concrete for the wall proper was deposited in 4-ft. lifts.

For each section of wall and wall footing, containing 235 cu.yd., three batch mixers were used, one in the bottom of the reservoir pit for the wall footing and two on top in spouting the concrete into the wall forms. It took from sixteen to eighteen hours to complete a section of wall.

In depositing the floor and roof concrete, step-back construction joints were allowed at the end of each day's run at the points of inflection in the panels. The concrete for the base and column shaft was deposited simultaneously, but the column head was poured with the roof slab. The reservoir wall and wall footing were constructed of 1 : 2 : 3 concrete, with 5 per cent hydrated lime. All other concrete had a 1 : 2 : 4 mix.

Tightness Tests—Under test only one leak showed, and this was at one of the expansion joints. It consisted of a stream, about the size of a pencil, coming out under pressure 8 ft. from the bottom of the reservoir. The leak did not show until there was 17 ft. of water in the reservoir. A special waterproofing treatment of the joint closed the leak. One other expansion joint showed some sweating at the start, but this joint sealed itself before the end of the week. The reservoir has developed no further leaks and is giving excellent service.

The tile drains have shown no water except for a short period this spring, when the two under the wall footing showed a slight flow. This water undoubtedly came from melting snow water seeping down the outside of the wall, as the backfill had not yet compacted itself against the wall sufficiently to exclude it.

The reservoir was designed by Kimball & Ullrich, consulting engineers, Salt Lake City, Utah, with the construction work carried out under the supervision of Frank Deming, city engineer of Provo. T. G. Rowland, Salt Lake City, was the contractor. The total cost of the reservoir was $90,074.57, or $18.01 per 1,000 gal.

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Singapore's New Railway System

A new $8,000,000 railway system on Singapore Island, including new bridges to eliminate grade-crossings, a new terminal station, freight sidings and auxiliary buildings, has been completed, according to a report from trade commissioner Donald W. Smith, Singapore, to the U. S. Department of Commerce. New equipment includes special devices for handling heavy and bulky freight. One traveling crane has a capacity of 35 tons. The terminal is said to compare favorably with any station in Asia. The new equipment is expected to expedite the handling of all types of freight. The seven new bridges along the 9-mile right-of-way eliminates fourteen dangerous grade-crossings within the city.

Articulated Spans With Tank Float Form Car-Ferry Landing

Float supports hinged connection of 40-ft. and 30-ft. spans—Chain hoists and counterweights adjust outboard end to height of ferry barge

BUOYANCY tanks for **car-ferry landing** bridges, in place of the usual heavy counterweights, are an unusual feature in the landings of a car ferry established recently at Mobile, Ala., by the Alabama, Tennessee & Northern Railroad to serve a new refinery of the Coastal Petroleum Corp. on Blakeley Island. Cars are ferried across by a wooden barge, 260x35 ft., with two tracks on its deck. This barge was used originally at the Bush Terminal, New York, and was towed to Mobile.

Each ferry landing consists of a 40-ft. girder span and a 30-ft. apron, which connects with the deck of the barge. Both the span and the apron have four lines of girders and are designed for Cooper's E-60 loading, with 50 per cent allowance for impact. The shore end of the 40-ft. span is seated on a pile and timber bulkhead, while the outboard ends of its girders are framed against a cross-girder supported upon a cylindrical tank by means of timber saddles. This tank, 8 ft. in diameter and 25 ft. 3 in. long, is of $\frac{3}{16}$-in. copper-bearing steel, welded throughout, and reinforced by four interior diaphragms.

Tank adjusts for tide range

The 30-ft. apron has its girders seated on brackets on the web of the cross-girder and supported at mid-length on a transverse beam or strongback composed of a pair of 15-in. I-beams 30 ft. long. The projecting ends of this beam are attached by hangers to cables that pass over sheaves on wooden towers and carry counterweights weighing about 7 tons each. Thus the floating tank adjusts the level for a tidal range of about 6 ft., while the outboard end of the apron can be adjusted to the varying height of the deck of the barge.

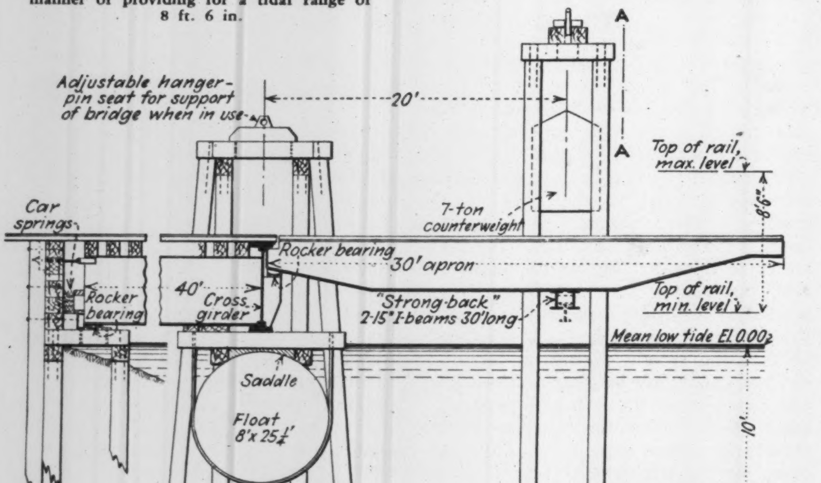


Fig. 1—Longitudinal elevation of the A.T.&N. Railroad ferry landing, showing manner of providing for a tidal range of 8 ft. 6 in.

To adjust the position of the landing, two 5-ton chain hoists are attached to the ends of the cross-girder, and two 4-ton chain hoists are attached to the end of the strongback, these hoists being suspended from towers of creosoted timbers that also serve as guides. During loading operations the apron hoists are disconnected to prevent their being broken by the live load of the railway cars.

The total dead-load reaction at the cross-girder (exclusive of the apron) is estimated at 31.42 tons, while the buoyancy or uplift of the tank is 3[illegible]83 tons. The apron weighs 19.68 tons. On the basis of these figures the apron strongback was so located and the apron counterweights so adjusted that the theoretical weight on each of the four chain hoists is about 1 ton. The excess power provides for ease of operation and a wide margin of safety.

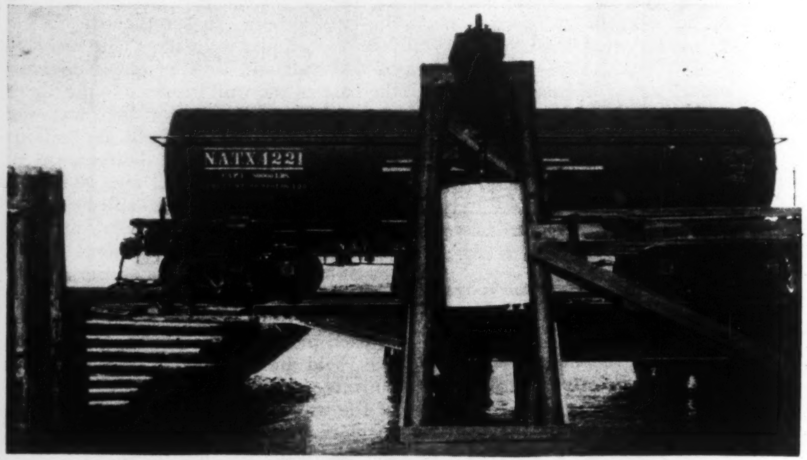


Fig. 2—Adjustment of the outer end of the bridge to its seat on the car float is by hand hoists aided by counterweights. When seated, the hoists are released to permit fluctuation under live load.

The girders of the 40-ft. span have convex bearing plates resting on concave shoes on the bridge seat to allow for the 6-ft. vertical rocking motion. Nests of car springs fitted between the girders and the back wall are provided to take up end shocks from the barge, while horizontal anchor bolts restrict longitudinal movement but allow for the rocking movement.

Rocker span is unique

The construction differs from car-ferry landings on the Great Lakes and their connecting channels in introducing the movable 40-ft. rocking span between the shore approach and the hinged apron.

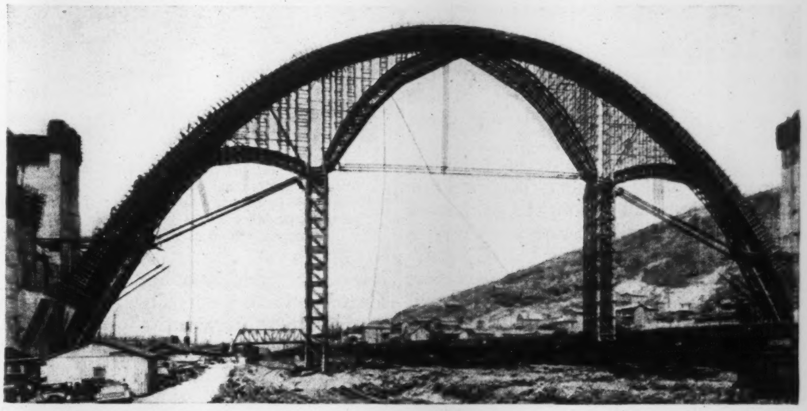
These Mobile car-ferry landings were designed by J. B. Converse & Co., Inc., engineers, Mobile, Ala., with E. M. Stickney in active charge; their design was according to a general plan prepared by R. F. Wills, engineer of ferries and terminals of the Southern Pacific Railway at New Orleans. The steel structures were detailed and built by the Virginia Bridge & Iron Co. at Birmingham, Ala.

Building America's Longest Concrete-Arch Bridge

A factual survey of modern construction practices as employed on the George Westinghouse Bridge at East Pittsburgh

TWO-HUNDRED FEET above the industrialized Turtle Creek Valley in East Pittsburgh, Pa., the five concrete arches of the new George Westinghouse Bridge carry a 42-ft. roadway whose use will save many a motorist the experience of traversing one of the most congested stretches of city street and winding rural road that could be found along the entire length of the Lincoln Highway. Briefly, the new link, of which the bridge is the most conspicuous part, eliminates 3.44 miles of heavy grades and bad alignment. It bypasses the narrow streets in the towns of East Pittsburgh and Turtle Creek. And it is three-quarters of a mile shorter than the former route.

The George Westinghouse Bridge claims a place in the select company of other great engineering achievements of recent years, such as the Holland Tunnel, the Hudson River suspension bridge and the Hoover Dam, all of which have captured the public imagination and offered a special appeal to the engineer. There is sound basis for this claim, for the new structure is spectacular in the service it renders, in the boldness of its design and erection, in the grace and symmetry of its architecture and in its location over a busy industrial valley in which three levels of highway and railway were already provided for. Moreover, it is structurally important as representing in its 460-ft. center span the longest concrete arch in America, as exemplifying the efficient use of pairs of wide shallow ribs with no cross-struts between as its principal load-carrying elements, and as embodying the relatively new principle of using floor-expansion joints only at the ends of the spans. And, finally, it is significant as a construction operation in which skilled field forces using modern equipment and ingenuity built deep foundations and carried out high-level work on schedule time and within close cost estimates. The construction phase of the work is the subject of this article, the design having been covered in an earlier article (*ENR*, April 23, 1931, p. 680).



Steel centering—three three-hinged tied arches—spanning 412 ft. between the piers of the longest span, was erected under one rib and then jacked sideways 32 ft. to a position under the second rib. The same centering trusses, without the towers, were used to concrete the two arches at either end of the bridge.

Linking the tops of the precipitous bluffs that form Turtle Creek Valley in East Pittsburgh, the new George Westinghouse Bridge eliminates a route that traversed the congested valley and the hilly country that appears in the upper left half of the view where the old winding road may be seen in the distance. The central 460-ft. span of the bridge is the longest reinforced-concrete arch in this country. The 130-ft. cut at the east end of the bridge and the 110-ft. fill beyond are also notable.

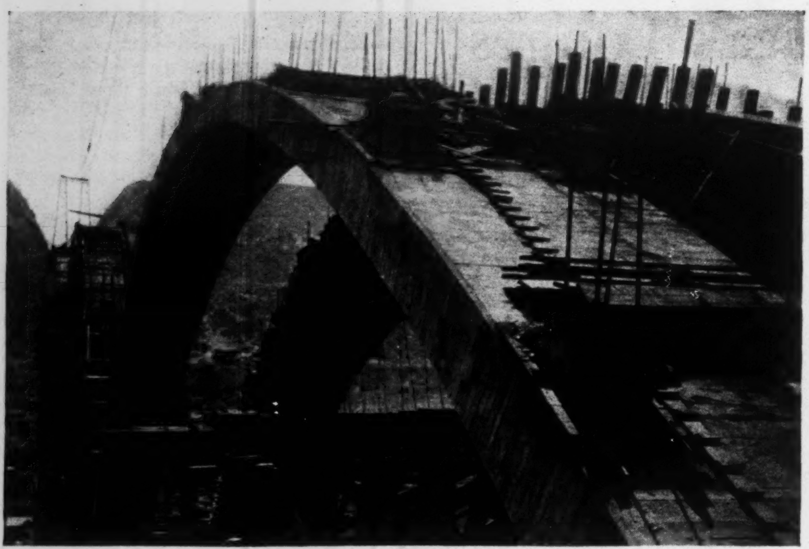
The job was to build a five-span reinforced-concrete arch bridge, 1,560 ft. long, in a location accessible at one end but blocked at the other until a cut 130 ft. deep could be made through the top of a steep bluff. One span was to be 460 ft. c. to c. of piers, with a rise of 156 ft. Flanking this span at either end, two spans about 195 and 280 ft. long, respectively, were to be built. The roadway was to be 200 ft. high above a valley occupied by a creek, a highway and a dozen busy railroad tracks. A total of 24,000 cu.yd. of excavation had to be removed in piers and abutments from 35 to 85 ft. deep. The height from the bottom of the deepest foundation to the top of the center pier was about 285 ft.

If a continuous moving picture of the job from beginning to end were available, certain important characteristics would stand out. These taken together would measure the contribution that this particular job has made to the art of construction. In such a movie "short" the reviewer would see that:

Structural-steel sheds, erected over the railroads and the highway beneath the bridge, were covered with unusually heavy plank roofing to withstand the impact of falling forms or timbers.

Piers were sunk as open caissons to a maximum depth of 85 ft., and not only were preparations that had been made to utilize air caissons not necessary but pumping was inconsequential.

Concrete paving mixers were set up



Twin ribs, 14 ft. wide and relatively shallow, simplified the concreting task, which also was speeded up by using high-early-strength portland cement concrete in the keys, permitting centers to be struck in three days. Cableway of 1,600-ft. span was used to erect centers and transport 5-yd. concrete buckets, form materials and reinforcing.

Centers were shifted sideways by means of 250-ton hydraulic jacks. On the center span the jacks were installed at the bases of the two steel tower supports as well as at the piers.

at each pier location, and all piers were poured to a height slightly above the arch spring line at the earliest possible moment, so that arch centering could be set.

Abutments were constructed simultaneously with the piers, concrete for the east abutment having to be hauled to the adjacent hilltop and slid down a 400-ft. chute to the forms 135 ft. below.

The principal item of equipment was a cableway system consisting of two $2\frac{1}{4}$-in. cables over the north rib, where the steel centering was first erected, and one $2\frac{1}{2}$-in. cable over the south rib. The cableway spanned 1,600 ft. between steel towers 150 and 110 ft. high, respectively, located on the opposite hilltops. In spite of the difference in tower heights, the two ends of the cableway were at about the same elevation, since the bridge roadway was on a 4 per cent grade. Unloaded, the cableway sagged 75 ft; carrying the maximum load of 30 tons, its sag was about 90 ft. Single-line speed of the cableway-trolley carriers was 2,500 ft. per minute, while the hoist-block speed on a five-part line was 500 ft. per minute.

With abutments complete, piers concreted up to the arch spring lines, and equipment in place, the scenes in the movie of job highlights would shift to the more spectacular phases of the work, showing that:

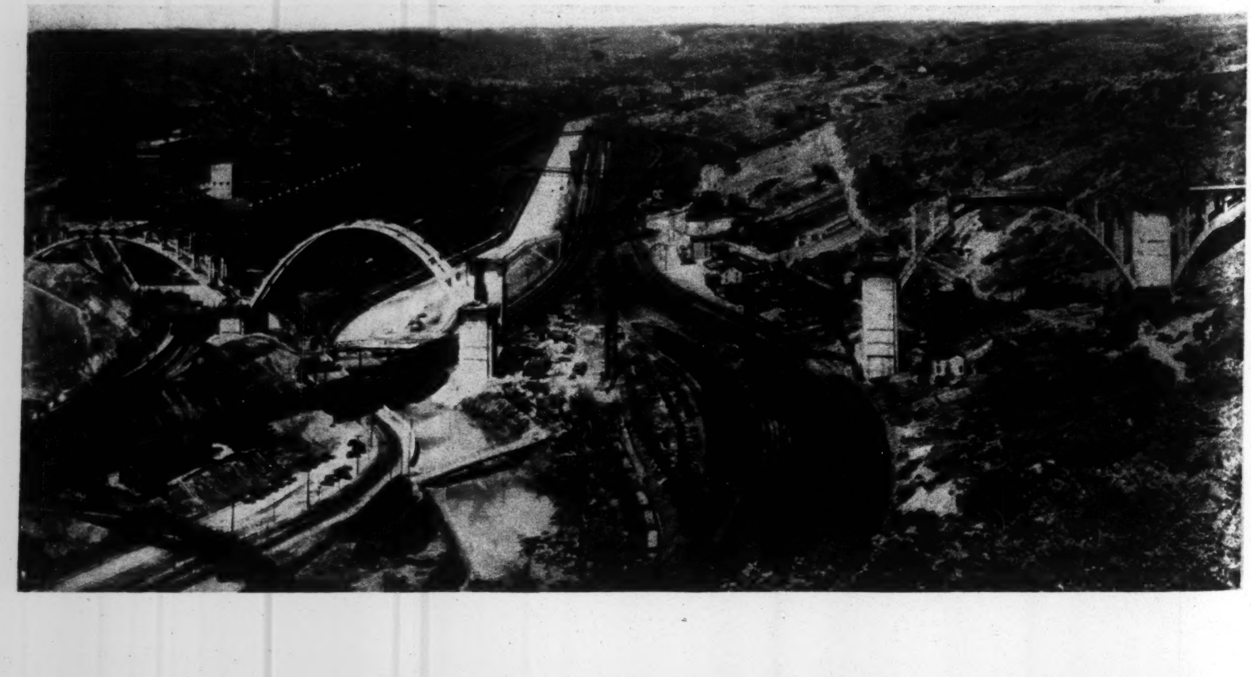
Steel-truss centering was used in all of the arch spans, so fabricated that it could be made to conform to the intrados of arches of different span lengths and so planned that the two arches at either end of the bridge would first be completed and then all of the centering assembled to support the 460-ft. span. A large amount of crossbracing was provided in the centering to resist wind pressure, in view of the long spans involved and the considerable rise of the arches.

Centering for each arch was erected with the two north cableway cables. The north rib was poured first, after which the rib centering was lowered and moved sideways into position under the south rib.

Supports for the centering consisted of structural-steel brackets and I-beams resting on recessed bases formed in the masonry, the I-beams carrying the trusses at the springing lines and being of such length as to support a channel track upon which the steel centering was moved from the north to the south rib.

The centering for the long span consisted of three three-hinged tied arches

Erecting centers for 460-ft. concrete-arch span of George Westinghouse Bridge. The new bridge forms the fourth traffic level in congested Turtle Creek Valley at East Pittsburgh, Pa.



carried not only by brackets on the piers but by two steel towers set 163 ft. apart. Rib forms were supported from this centering by means of light steel falsework.

When moving the centering ahead from one arch to another, it was transported by the cableway in sections weighing not more than 13 tons. Shifting the centering from the north to the south rib in any one arch was accomplished by means of 250-ton jacks. For the long span, in which the centering weighed about 750 tons, jacks were used not only at the haunches but also at the two towers, which also were shifted. Eight men were required for this major shifting operation.

The central mixing plant was located adjacent to one of the bridge piers at the lowest point in the valley to which aggregate could conveniently be trucked. Concrete for the structure was delivered by cableway in 5-cu.yd. buckets, some going directly into the forms but a large part being rehandled by two stiff-leg derricks located on the bridge deck.

Pier work above the spring line was carried out simultaneously with the pouring of the ribs, spandrel columns and deck concrete.

In the deck, which is of T-beam design, monolithic construction was avoided in order to simplify formwork.

Steel reinforcing was assembled and rigidly supported in the forms by structural-steel cross-frames at 15-ft. intervals, and, in the five keyways provided in each rib lap-welded splices 40 diameters long were made (*ENR*, March 24, 1932, p. 435).

Crushed limestone aggregate was used in the concrete for the ribs, columns and deck. It was batched by weight and required more care in placing than the gravel concrete that was used in the abutments and piers. Spans 1 and 2, on the east end of the bridge, were poured first, followed in order by spans 5, 4 and 3.

Electric vibrators were used in placing concrete in the ribs and other thin members because of its rather stiff consistency.

By virtue of the use of high-early-strength portland cement in the rib keys, centering was released three days after placing the last concrete in the rib, an expedient that saved about 95 days on the contract time. Spandrel column forms were always in place ready to receive the concrete on the day following completion of the arch rib.

Work began May 15, 1930, and was completed Dec. 28, 1931. The bridge was designed by the Allegheny County department of public works and financed jointly by the county, the state highway department and the federal government. The contractor was Booth & Flinn Co., Pittsburgh, of which A. Rex Flinn is president, George Hockensmith vice-president and general superintendent, and Norman McLain field superintendent. V. H. Covell is chief engineer of the bureau of bridges, Allegheny County.

Street-Widening Experience Counsels Against Haste

Twelve years of progressive widening by setback lines and direct appropriation in Akron, Ohio, indicates that caution should be exercised in pushing projects unless traffic imperatively demands more lanes

By E. A. Kemmler
Advisory Engineer for City of Akron, Ohio

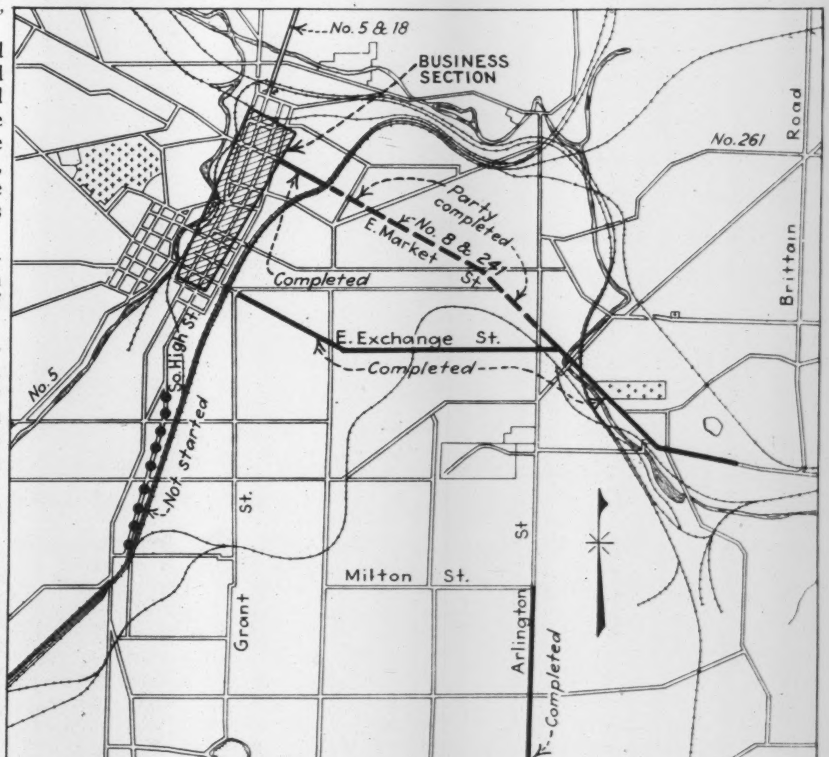
TEMPORARILY, Akron, Ohio, has recessed from three years of continuous activity on a program of widening 6 miles of main thoroughfare at an estimated cost of $4,280,000. More than 500 property and damage settlements were made, 99 per cent by negotiation. Although the program is but 75 per cent complete and activity will not be resumed until the financial situation returns to normal, some of the pitfalls awaiting the uninitiated public official and a few unit-cost prices may now be given with profit.

The Akron street-widening program was launched in 1919, when the city council, upon recommendation of the planning commission, passed building setback ordinances covering 20 miles of main thoroughfares. The setback distance varied from 4 to 15 ft. These ordinances, of questionable validity, were immediately respected by property owners in erecting new buildings.

In 1922 a general setback plan that included all of the streets in the 1919 program was made a part of the zoning ordinance enacted by the council in August of that year.

During the ten years following the passage of the original setback ordinances almost 200 new business and factory buildings were erected on the streets included in the 1919 program, effecting a saving of nearly $3,000,000, computed by multiplying the cubical contents of buildings that would have occupied the setback space by the average cost per cubic foot of buildings

Street widenings undertaken and planned in the business district of Akron, Ohio



appropriated in connection with the actual widening process in 1929-1931.

Under the scheme of widening these thoroughfares automatically by setting back all new buildings, it was estimated that the result would be accomplished in 40 to 50 years. However, in 1928 the feeling became more or less general that the program needed some artificial stimulant to speed it up, and a bond issue of $2,140,000 for the city's portion of the cost of widening certain selected streets, totaling 30,460 ft. in length, was submitted to the electorate in November and approved by a generous majority.

This is about 30 per cent of the original program. It was planned to assess 50 per cent of the cost (the limit in Ohio) against the abutting properties according to benefits.

Immediately after this decision the election surveys were started and appraisal maps prepared as speedily as possible. As rapidly as these were completed, they were placed in the hands of the appraisal committee of the real estate board, which placed values of lands and buildings on every parcel required. This preliminary work was completed early in 1929. This type of appraisement was new to the committee, and the values fixed by them were generally too low, largely because they overlooked or underestimated the following factors:

1. Damage to residential property by moving street lines to within a few feet of house or porch.
2. Values of leasehold interest.
3. Under Ohio law the entire building must be taken by the city at option of owner, if cutting off a portion causes manifest injury to the remainder.
4. The percentage values in appraisal tables based on the theory that the rear and not the front portion of the land is taken do not apply indiscriminately in the case of lots with buildings on them.

The average front-foot values of land only for lots 100 ft. deep, as estimated by the appraisal committee, ranged from $90, where the percentage of business and manufacturing was 22 per cent, to $600 and $800, where it was 100 per cent. Of a total number of 616 lots 83 were vacant and 93 were less than 100 ft. deep after widening. There were 152 buildings in the widening strip, 63 of wood and 89 of brick. Seven were moved back, eight rebuilt, 125 cut off and twelve removed.

The estimated saving in widening cost due to the 1919 setback ordinance based on unit costs, obtained from actual damage sustained where buildings on the strips taken were demolished or removed, amounted to $931,000 for 47 buildings with a volume of 759,000 cu.ft. These 47 buildings were built on the setback line subsequent to the passage of the 1919 setback ordinance.

After legislative procedure was completed a purchasing organization was created. It consisted of a real estate agent to obtain as many friendly option settlements as possible and an advisory board made up of the directors of law, finance and service, three members of the council and the highway engineer, to review and approve the options submitted by the real estate agent and to hear owners and their attorneys in cases beyond the ability of the real estate agent to secure options at reasonable figures. This body became known as the board of review.

This board held 719 meetings, averaging about three hours each, to Jan. 1, 1932, and heard 300 cases, all except four of which were settled without the aid of a jury. In three of the cases tried before a jury the verdicts were slightly less than the last offers made by the board, in the fourth case the amount was somewhat higher. The board of review did a magnificent piece of work, undoubtedly speeding up the work and saving the city thousands of dollars, by breaking down extravagant claims of property owners.

After twelve years' experience with progressive widening by means of setback lines and with direct appropriation, the writer has reached the conclusion that no set rule can be established in respect to the amount that it would be wise and justifiable to expend for the immediate widening of city thoroughfares. He is satisfied, however, that assessments exceeding 20 per cent of the land values of abutting property are not justifiable, unless the traffic requirements make it imperative. Since the life of the surface street-car now appears to be limited to only a few more years in the average city of 300,000 or less, it is advisable to exercise caution and patience in the matter of widening such thoroughfares now. The removal of the tracks and perhaps setting back the curbs a few feet at the expense of the sidewalks may bring the same results at little cost. If this does not appear sufficient for the future, setback lines can be established in addition, also without much expense, until the actual taking of the land in the setback strips.

The Akron program of widening appears to have been justified by reason of congestion of traffic, particularly along the plant of the Goodyear Tire and Rubber Co., where the roadway is 40 ft. wide and double tracks occupy the center. But after completing the bulk of this enterprise we feel certain that five or ten years more would have practically completed the work by means of the setback plan, as the great majority of buildings for which the city has now provided new modern fronts and remodeled interiors were about ready for the scrap heap anyhow. A million or so could have been saved by the exercise of a little patience, curb-parking prohibition and improvement of the street intersections and car-stop zones, where all congestion originates. If we could persuade ourselves to spend our efforts and money at the intersections first and increase their capacities for passing all kinds of traffic with safety and dispatch, it is conceivable that many of the street-widening projects that now look imperative may be unnecessary.

TABLE I — TOTAL AND UNIT COSTS OF LAND AND BUILDINGS TAKEN FOR STREET WIDENING, AKRON, OHIO

Street	Land Taken, Sq.Ft.	Total Cost of Land Taken	Damage to Residue of Land	Cost* Per Sq.Ft.	Total Volume Buildings Destroyed, Cu.Ft.	Total Buildings Paid for	Damage to Residue of Building and Ret. Walls	Total Cost* Per Cu.Ft. of Buildings Destroyed
S. Arlington St. Milton St. to Wilbeth Rd.	73,130	$20,922	$12,124	0.452	11,500	$2,050	$2,450	$0.392
E. Exchange St. — Sec. A Grant to Spicer St.......	78,144	98,969	10,000	1.394	246,097	131,122	69,783	0.816
E. Exchange St. — Sec. B Spicer to E. Market St...	106,446	91,336	20,000	1.046	136,600	146,732	55,582	1.490
E. Market St. — Sec. A High to College St.......	18,318	56,975	3,691	3.312	80,920	109,827	33,593	1.772
E. Market St. — Sec. B College to Arlington St...	(Not	completed)						
E. Market St. — Sec. C Arlington to Cook St....	57,715	238,875	53,470	5.065	616,851	810,704	124,546	1.516
E. Market St. — Sec. D Cook to Wigley St.......	24,488	64,723	25,528	3.686	77,080	89,800	7,385	1.261
S. High St. Hackett to Miller St.....	(Not started)							
Total................	358,241	$571,800	$124,813	.....	1,169.048	$1,290,235	293 339	..
Averages............				1.944				$1.355

*Including damage.

TABLE II — BUILDING VOLUME, LAND VALUES AND RATES OF ASSESSMENT BASED ON 50 PER CENT OF THE COST

(Showing wide variation between suburban and central city widening)

Project	Assessable Frontage	Per Cent of Setback Strip Area Occupied by Buildings	Appraised Land Value Per Foot Front	Rate Per Front Foot Assessment	Remarks
South Arlington St. — All..........	8,810	0.70	$90	$2.46	Suburban
E. Exchange St. — Sec. A..........	5,910	14.60	250	30.41	....
E. Exchange St. — Sec. B..........	8,410	4.80	150	21.40	....
E. Market St. — Sec. A..........	1,776	29.30	800	46.57	....
E. Market St. — Sec. B..........	11,097	11.20	375	33.30	....
E. Market St. — Sec. C..........	5.454	45.00	600	99.96	Central City
E. Market St. — Sec. D..........	3,390	19.00	275	30.52	....

Reinforced Brickwork: A New Construction Material

Recent applications of this novel brick-steel construction include a variety of structures—Tests indicate high strength

REINFORCED brickwork, although first used by Brunel in England more than a century ago, may truly be characterized as a new construction material, for it is only within the past few years that any concerted effort has been made to utilize it in this country. On the other hand, it has been used extensively and for many years abroad, especially in India and Japan, as noted in *Engineering News-Record,* July 24, 1930, pp. 121 and 142, and Feb. 21, 1929, p. 304.

In this system of construction the horizontal and vertical steel reinforcement is placed in the mortar joints in practically the same amount and arrangement as for similar construction in reinforced concrete. Design is still more empirical than scientific. However, new test data are rapidly being accumulated, and several scientific studies are being planned, so that the next few years should witness considerable progress toward a rational design procedure. Recent examples of reinforced brickwork in this country include cylindrical storage bins, trestle piers, a tank inclosure, a small bridge, and a variety of columns, girders, joists, floor slabs, lintels and building walls. The most important of these, as well as two pioneer American applications of reinforced brickwork, will be described in this article. Brief mention is also made of some of the recent test data. A reinforced-brickwork bridge was described in *Engineering News-Record,* Jan. 29, 1932, p. 118, and a water tank inclosure in the issue of June 23, 1932, p. 892.

For reinforced-brick construction, common hard-burned brick is generally used, although other kinds are suitable. The bricks are laid in 1 : 3 cement mortar tempered with a small amount of lime to improve the workability. Steel reinforcement consists mainly of straight, deformed bars or rods with loops or ties in the columns, but bent bars and stirrups have been introduced in some cases to resist shear. Wire mesh has also been used to some extent. It is considered advisable to have a minimum thickness of $\frac{1}{8}$-in. mortar on bars up to $\frac{1}{2}$ in. in size, with a greater thickness (up to $\frac{1}{4}$ in.) on larger bars. Mortar joints are made slightly thicker where the reinforcing occurs, although in Japan a special form of notched or perforated brick has been developed, as described in *Engineering News-Record,* July 24, 1930, p. 142. Bricklaying speed is said to be about the same as in ordinary construction. The forms required to support horizontal surfaces of beams or slabs for a sufficient time to allow the mortar to set are of much simpler construction than for concrete work, since they do not need to be watertight.

Fig. 2—First modern large structure of reinforced brickwork is a group of sand storage bins supporting a screen house and built in 1931.

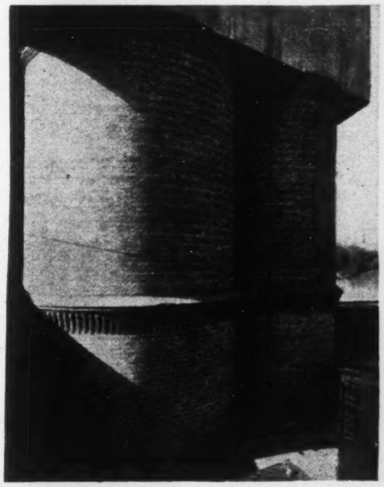
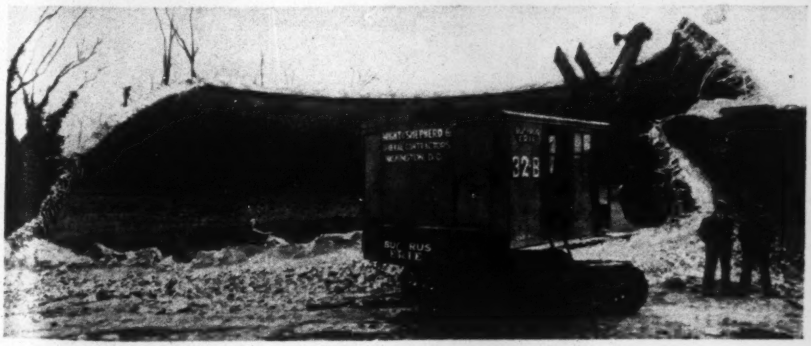


Fig. 1—Reinforced with wrought-iron straps, the dome-shaped Georgetown reservoir in Washington, D. C., built in 1861, was one of the first examples of reinforced-brick construction in this country. It was demolished early this year.



Early American reinforced brickwork

Two of the oldest examples of the use of metal reinforcing in brick structures in this country are the Georgetown reservoir in Washington, D. C., completed in 1861, and a dam near Ithaca, N. Y., built in 1905, in which reinforced-brick facing was utilized as forms for the concrete that comprised the body of the dam.

The Georgetown reservoir, which was taken out of service in 1897, was not generally known to contain reinforcing until it was demolished early this year to provide space for a new library. Then it was discovered that straps of hoop iron up to $\frac{1}{4}$ in. in thickness and up to 2 in. in width had been used extensively in the mortar joints. No record is available concerning the design of the structure. In the specifications written in 1858 by Capt. M. C. Meigs, Corps of Engineers, U. S. Army, and chief engineer of the Washington aqueduct, it is stated that, "Hoop iron will be built into the brickwork as directed by the engineers, forming a strong and sufficient bond."

As indicated in Fig. 1, the reservoir was in the form of a dome open at the top. Its base diameter was about 120 ft. and the diameter of the opening at the top about 80 ft. The original plan called for a complete hemispherical dome with a rise of 50 ft. The rise as built was about 40 ft., and the wall overhang was about 25 ft. The water line was fixed at 20 ft. above the base, and the dome was backfilled to this height with an exterior embankment. Walls, of hand-made brick, were 24 in. thick and founded on concrete footings $2\frac{1}{2}$ ft. deep by $5\frac{1}{2}$ ft. wide. Mortar joints were specified to be not greater than $\frac{3}{8}$ in. thick.

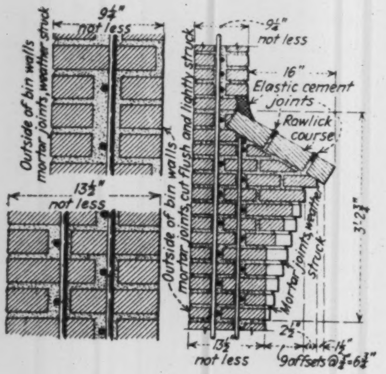
The wrought-iron strap reinforcing was placed flat in every third course, while that set on edge did not follow any regular pattern, according to persons who viewed the demolition. The straps set on edge were of heavier gage than those laid flat. Most of the wall reinforcing was placed in the lower two-thirds of its height. A test made of a short piece of the strap iron, 2 in. wide by 0.09 in. thick, showed a unit strength of 46,500 lb. per sq.in. A similar test on a piece $1\frac{1}{4}$ in. wide by 0.06 in. thick showed a strength of 56,500 lb. per sq.in.

In the Ithaca dam, an arch structure about 30 ft. high and 6 ft. through at the widest section, 4-in. brick walls reinforced with hoop iron in the horizontal joints were built as the upstream and downstream faces. These walls were tied together and served as forms for the concrete body of the dam. During construction of the brick walls, at a time when they stood about 4 ft. above the concrete, they successfully withstood a flood that overtopped them. The dam was designed by Gardner S. Williams and was built by Vinton & Tucker, contractors.

Recent applications

Sand Storage Bins—Of two bins of 2,100 tons combined capacity, built in 1931 as a unit structure for the storage of silica sand at the plant of the Wedron Silica Co., Wedron, Ill., one is 25 ft. and the other 16 ft. in inside diameter, the larger one having a vertical partition. They are both of the same height, 52 ft., and together support the screen house (Figs. 2 and 3). This is believed to be the first large structure of reinforced brickwork that has been built in this country. For the larger bin the wall thickness is $13\frac{1}{2}$ in. for a height of 22 ft. and then 9 in. to the top, while its partition wall is 21 in. for 14 ft., 17 in. for 22 ft. and 13 in. for 16 ft. The smaller bin has a uniform wall thickness of 9 in. For architectural effect both bins have a corbelled belt course and cornice.

Fig. 3—Design of reinforced-brickwork bins for 2,100 tons of sand, showing disposition of steel rods.

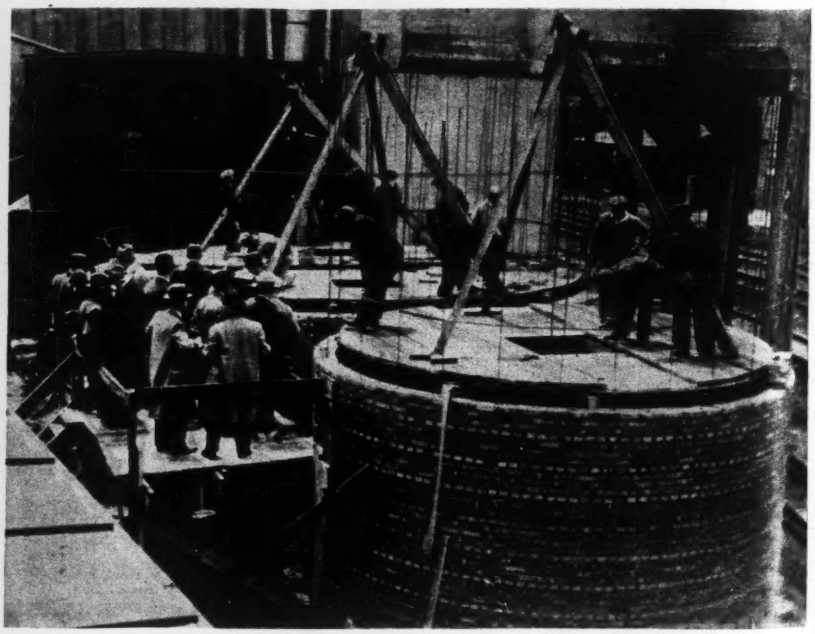

9¼" not less
Outside of bin walls mortar joints, weather struck
13½" not less
Outside of bin walls mortar joints cut flush and lightly struck
9¼" not less
16"
Elastic cement joints
Rowlick course
Mortar joints weather struck
3'-2¾"
2½"
13½" not less
1½"
9 offsets @ ¾"=6¾"

In construction circular wooden templets were used to insure accurate spacing and alignment of the first run of vertical bars, which are connected to dowels or stub bars projecting from the brick footings. Square openings with temporary wood lintels were provided in the bottom of the wall for handling material to the interior, the horizontal bars projecting into the sides of the opening for future connection with short bars to complete the reinforcement when the openings were closed by brickwork. A circular platform resting on cross-timbers seated on the brick wall served the bricklayers (Fig. 4) and carried a tripod with cable and pulley for hoisting material through a central hole.

Common bricks were used throughout and were wetted in the pile with a hose but not dipped or soaked. Machine-mixed mortar was a 1 : 3 mix of cement and sand, tempered with 18 per cent of high-magnesian lime. Reinforcing steel in the 25-ft. bin consists of $\frac{1}{2}$-in. vertical bars spaced $21\frac{1}{2}$ in. c. to c., and horizontal bars ranging from $\frac{1}{2}$-in. bars at 3-in. spacing c. to c. at the bottom to $\frac{3}{8}$-in. bars of $5\frac{5}{8}$-in. spacing at the top. In the smaller bin the vertical reinforcing is the same; but while the horizontal bars are of the same size, they have a uniform $5\frac{1}{2}$-in. spacing. Both straight and bent bars are used in the 25-ft. partition wall. The cost of this construction is said to have been substantially the same as the bid for a competitive design in reinforced-concrete construction.

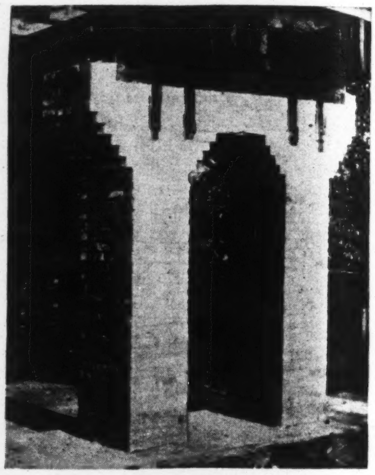
Trestle Piers—At the same plant was a 293-ft. trestle with 21 spans of 14 ft., consisting of timber stringers on frame bents with concrete footings. These bents have been replaced with reinforced-brickwork piers, which are 7 to 12 ft. high (Fig. 5). The structure is partly on a curve of 11 deg., and its lower end has a grade of $1\frac{1}{2}$ per cent. In each pier the posts are $21\frac{1}{2}$x$25\frac{1}{2}$ in. in section, 5 ft. c. to c., with the sides corbelled out to form a cap or beam 9 ft. long. This beam is reinforced with six $\frac{3}{4}$-in. bars. The beam is not subject to bending and serves only as a tie, all track load being carried directly by the columns. This design was based on a 105-ton car as live load. The contract price was $1,675, as compared with a bid of $2,877 for steel bents. No bid was made for reinforced concrete.

Fig. 4—Working platform on sills carries bricklayers and material for building sand bins of 2,100 tons capacity of reinforced brickwork.



In construction the stringer spans were supported by three sets of cribbing of track ties, while the old frame bents were removed one at a time, the old concrete footings being then drilled for dowel rods, which were grouted in place. Each column has six $\frac{3}{4}$-in. vertical bars with rectangular hoops or ties of $\frac{1}{4}$-in. steel in every third mortar joint, or about $8\frac{1}{2}$ in. c. to c. In the cap there were six $\frac{3}{4}$-in. horizontal bars with looped ends. There were 26,100 bricks in all, averaging 1,243 to each pier. Construction work was rapid, two men averaging three piers every two days. The entire job was completed in fourteen days, including the crib supports and removal of old bents. Loading was transferred from the cribbing

Fig. 5—Reinforced-brickwork pier for coal trestle at Wedron, Ill. Loads are carried directly on columns, the beam, although reinforced, acting only as a tie.



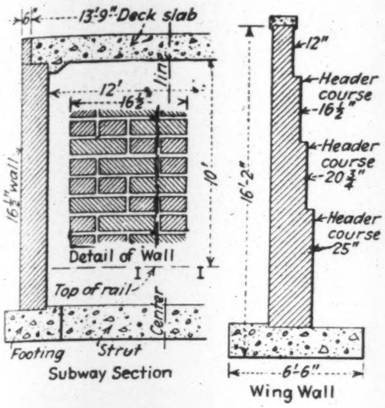


Fig. 6—Subway beneath highway in Arkansas utilizes side walls and wing walls of reinforced brickwork.

to the piers in 24 to 48 hours. Forms were used only for the soffit between the columns; they were of light construction and easily removed. The bricklaying averaged 932 per man per eight-hour day, while the time per 1,000 bricks averaged 8.6 hours for bricklayers (including placing of reinforcement) and 12.9 hours for common labor.

Track Subway—In carrying a 30-ft. highway over a pit track of the Acme Brick Co., at Perla, Ark., the Arkansas state highway commission used reinforced brickwork for the side walls and wing walls by request of the brick company. Reinforced concrete was used for the deck slab and footings, the footings of the side walls being braced by concrete struts 14 ft. apart. This structure (Fig. 6) is about 30 ft. long between portals, with a clear span of 12 ft. and 13½ ft. high.

Its brick side walls are 16½ in. thick, with reinforcement of ½-in. bars, the horizontal bars being spaced 16½ in. and vertical bars 8½ in. c. to c. These vertical bars have looped ends embedded in the concrete footings and deck slab. In the brick wing walls, 10 and 18 ft. long, with a maximum height of 16 ft., the thickness ranges from 25 in. (six bricks) at the bottom to 12 in. (three bricks) at the top, which has a concrete coping. Hard-burned common brick was laid in 1 : 3 cement mortar having 10 per cent of hydrated lime (10 per cent of volume of cement). About 61,000 bricks were used on this job.

Conveyor House—A horizontal pit or tunnel 60 ft. long for a belt conveyor handling clay at the plant of the Price Brick Co., Chester, Pa., had a timber floor that was rebuilt with reinforced brickwork for girders, joists, slab and belt trough, the concrete walls being retained. In testing one of the floor slabs, 26x48 in. and one course thick (3¾ in.), reinforced with eight straight bars, it carried 995 lb. per sq.ft., with a deflection of only 7/32 in., the test not being carried to destruction.

Building Construction — Reinforced brickwork has been used in various parts of industrial buildings. A garage built in Chicago in 1929 for the Atlantic & Pacific Tea Co. has nine columns of this construction in the rear wall, including the corner columns. They are 32 in. square and 26 ft. high, each with six 1-in. vertical bars and horizontal hoops or ties of 5/16-in. bars at intervals of 8½ in., or in every third mortar joint. The reinforcing bars of the concrete floor are bent down into the columns. This construction was approved by the city building department. Lintels of 4- to 8½-ft. span in walls 8 and 12 in. thick have been built for window openings in three or four buildings. At a plant of the Commonwealth Edison Co., Chicago, reinforced brickwork has been used for a wall separating the terminals of transmission lines. This wall, about 10 ft. high, is 13 in. thick, reinforced on each side with ½-in. vertical bars 12 in. c. to c. and ⅜-in. horizontal bars 18 in. c. to c.

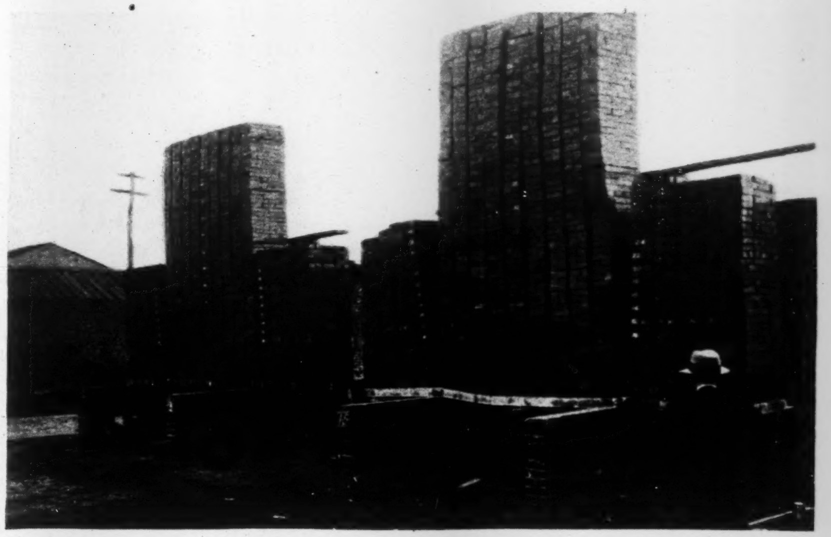


Fig. 7—Typical demonstration test structure under load. Beams have a clear span of 8 ft. and are 18 in. deep. Slabs span 8 ft. c. to c. of beams and cantilever 4 ft. at either end. Load on center-span slab of structure at left is 1,320 lb. per sq.in. with a deflection of 0.58 in., and on structure at right 1,408 lb. per sq.in. with deflection of 0.46 in. Soldier bond beam at right failed at 13,475-lb. load and 0.175-in. deflecton. Other beams with running bond carried average of 13,500 lb. at 0.25-in. deflection.

Reinforced-brickwork tests

Apart from actual construction, numerous tests have been made to determine the strength of beams and slabs of reinforced brickwork. Eugene S. Powers, consulting engineer, Philadelphia, made some of the earliest tests in this country in 1923. In 1924 Danforth, at Case School of Applied Science, Cleveland, and in 1928 Vaugh, at the University of Missouri, added important test information to the literature of reinforced brickwork. In the past two or three years several brick plants have built demonstration structures, as shown in Fig. 7, and tested them to failure. About fifteen of these structures have been so tested with uniformly good results. In 1930 the subject of bending, shear and bond in reinforced brickwork was investigated at the University of California. The most recent series of tests (eighteen beams) was carried out in 1931 at the Bureau of Standards at Washington. The tests were made in cooperation with the Common Brick Manufacturers Association to determine the effect of the arrangement or bonding of the beams on diagonal tensile stresses. Common brick was used in the construction of the beams, which were 14 ft. long and about 1 ft. square. In one type the bricks were laid in common American bond, as in a 12½-in. wall; in another the bonding was similar to that in a lintel beam, with a soldier course forming the lower part of each face, over which were laid two stretcher courses. The third type was built on end with vertical reinforcement to resemble a portion of a 12½-in. retaining wall, with all bricks laid as stretchers. Each beam contained six ½-in. square bars as tensile reinforcement. The mortar used was a 1 : 3 mix of portland cement and sand, with an addition of lime equal to 15 per cent of the volume of the cement.

The tests were made by supporting the beams on a 12-ft. span and applying equal loads at the quarter points. The load was increased by small increments until the deformations indicated that the stress in the steel was at least 15,000 lb. per sq.in. Then the load was reduced to a total of 1,000 lb. and finally increased by small increments until failure occurred. The set remaining after the first loading was roughly one-fifth of the maximum deformation before reducing the load, which is of the same order of magnitude as has been observed with reinforced-concrete beams of about the same initial stiffness. The maximum shearing stresses ranged from 60 to 160 lb. per sq.in., the values depending chiefly upon the kind of brick and their bonding in the beams. Cracks that tended to follow diagonal planes between the supports and the nearer loads formed before the beams failed. In some instances these cracks passed through the bricks, their location being apparently unaffected by the mortar joints; in other cases the mortar joints were opened along irregular lines.

Some typical results from some of the other beam and slab tests that have been made in recent years give some idea of the magnitude of loads carried and the action of the members. Beams 12x17 in. on an 8-ft. clear span, reinforced by five ½-in. longitudinal bars, failed at 13,000 and 10,720 lb. center load, or 7¼ and 6 times the design load. A one-course (3¾-in.) slab 13 in. wide and 6 ft. long, reinforced with three straight ½-in. bars, when loaded at the third points, carried a load of 5,000 lb., equivalent to 1,000 lb. per sq.ft., with a deflection of only 0.08 in. In buildings such a slab would have to carry a live load of only 40 to 60 lb. per sq.ft.

Reinforced-brick beams 8x13⅜ in., 10-ft. span, having three ⅜-in. bars, failed at loads of 3,980 to 6,500 lb., or 398 to 650 lb. per foot, while similar beams without reinforcement failed at 240 to 574 lb. (24 to 57 lb. per foot). The deflection was 7/16 to 13/32 in. for the former and 1/32 in. for the latter. Slabs, one brick thick, 30 in. wide and 5 ft. in span, with six ¼-in. bars, carried live loads of 3,390 to 4,220 lb. (271 to 338 lb. per sq.ft.), with a maximum deflection of 9/16 in. Similar slabs, 34 in. wide and 8 ft. in span, having six ⅜-in. bars, carried 6,200 to 9,000 lb. (274 to 397 lb. per sq.ft.), with a maximum deflection of 29/32 in. All these beams and slabs were tested to destruction.

Results of tests

Conspicuous results of such tests have been: (1) the high breaking loads as compared with the design live loads; (2) the slight deflection under heavy load; and (3) the frequent full recovery from deflection after removal of the load. In tests to destruction the failures are reported to have been by diagonal tension where beams were not reinforced with bent bars or stirrups, or both. In slabs and in beams reinforced for shear, the failures have been almost invariably in the mortar, without crushing of the bricks, but in some tests bricks have cracked in tension under ultimate loads.

Ditching and Laying Plant for Underground Cable

Rapid progress made in devising and coordinating equipment for constructing long cross-country underground telephone cable lines

THE CONTINUING increase in the number of telephone messages between cities and the constantly greater demand for dependability of service has led progressively from a multiplication of open-wire lines on poles to cable lines on poles, and recently to underground cable lines. The change to underground cables is largely for increased dependability of service rather than for message capacity. With only the objection that the location and correction of line troubles are more difficult, these underground cable lines have less risk of external injury and are often less expensive in right-of-way and construction. They also suffer less electrical interference from parallel power lines. A technique of construction has been developed in this underground cable work that is of interest to the civil engineer for the equipment used and its combination into trains. These subjects are reviewed in the following article from information furnished by C. W. Hystrom, general outside plant engineer, Southwestern Bell Telephone Co., St. Louis, Mo., and in the article immediately following, which describes a cable-laying machine that has been developed for the United Electric Works of Weissenfels-Zeitz, Germany. —EDITOR.

THE OPERATIONS in constructing underground telephone cable line, except in city areas where conduit is used, are ditching, cable-laying and backfilling. The controlling construction conditions are that the lines are long and are cross-country, and many kinds of terrain have to be traversed and all types of soil excavated. The cable loads are heavy, and the hauls are long. Reasonable economy of construction under such conditions demands mobile plant and equipment that will travel freely nearly anywhere and will, to the greatest possible degree, complete construction as it moves along. These mobile plant units and their successful operation in train have been quite completely worked out in a few years, as outlined here. The development may be divided into two periods, one of experimentation and one of established practice.

Line structure

No tile or other cable conduit is used, the cable being laid directly in the bottom of the ditch. This requires a special cable armoring. Lead-sheathed cable is wrapped with paper covered with two layers of jute roving. Over this is a spiral winding of 2-in. steel tape 40 mills thick applied in two layers; each spiral is wound with a

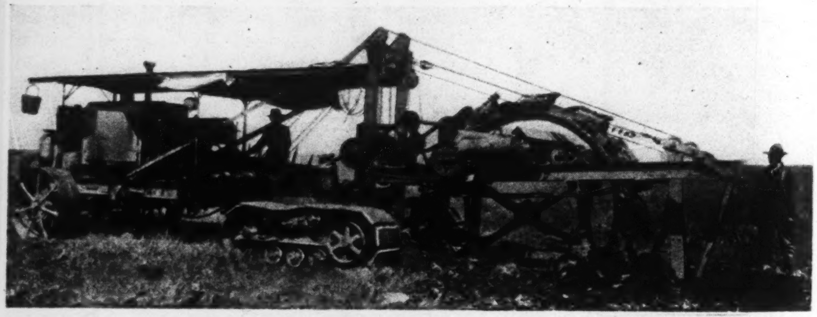


Fig. 1 (Upper view)—Original ditching unit for underground telephone cable construction was essentially of standard trench-excavator type.

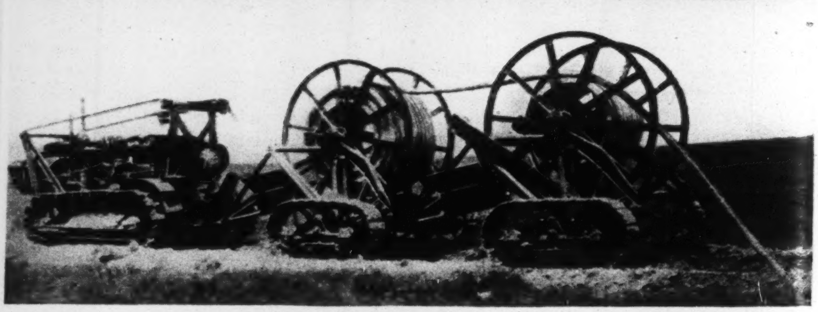


Fig. 2 (Lower view)—Cable was originally laid as a separate operation after the trench was excavated; original spoked reels and crawler-mounted reel trailers were afterwards improved.

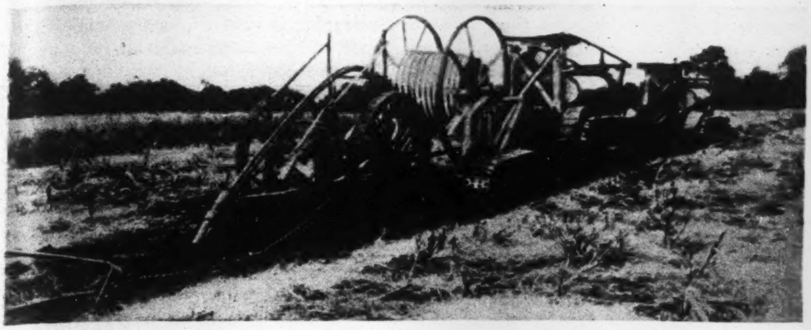


Fig. 3—First step in developing cable-laying train after the invention of the cable-laying plow; train is made up of hauling tractors, cable-reel trailer, cable-laying plow and backfiller, which is just off the picture.

½-in. space between adjacent turns, and the outer spiral covers the spaces between the inner spiral windings. Two wrappings of jute cover the tape. The lead sheath, paper, jute and steel tape are thoroughly coated with an asphalt compound, and the final coating is whitewashed to prevent the turns of cable on the reel from sticking together. As made up in the manner described, the cable is 3½ in. in diameter and weighs 11.3 lb. per foot, or about 5 tons per 750-ft. reel, including the reel.

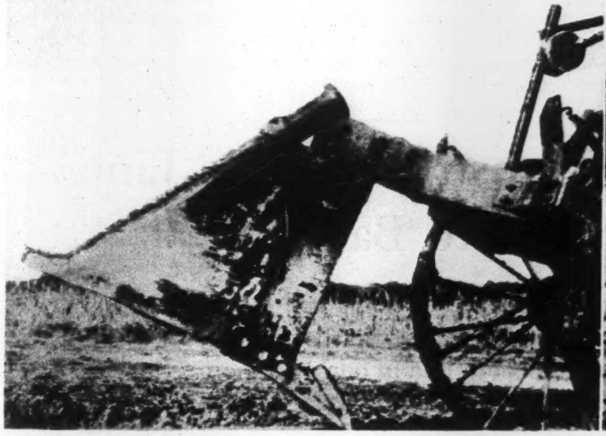


Fig. 4—Plowshare containing cable tube as first developed; this ditching unit was afterwards improved in both share and carriage design, as shown by Figs. 5 and 6.

The line structures include a cast-iron casing or wood-box splice covering at about every 750 ft., and manholes at about every 6,000 ft. The manholes, which in city work are concrete or brick vaults, are, for cross-country line, creosoted wood boxes 12x4 ft. and 3 ft. deep, with a cover but no bottom. Their tops are buried at least 18 in. deep.

Pioneer equipment

The pioneer plant for underground cable-line construction consisted of three separate equipment units: (1) a trench excavator or ditching machine, (2) a tractor-hauled cable-reel carriage, which unwinds the cable into the trench, and (3) a standard crawler-mounted trench backfiller. The second unit is really a double unit composed of a cable reel and a reel carriage. All these machines have undergone a change in character and have been combined into a single train or cable-laying plant, as described later. Taking up the changes in the several units, the evolution was generally as follows:

Cable comes to the work in reels of 750 ft. of cable, weighing with the reel about 5 tons. The regulation spoked reels (Fig. 2) for lead-sheathed cable proved unadaptable for the heavier tape armored cable, which, when the reel tipped sidewise in handling, crushed against the spokes and received indentations or bruises. Also the outside turns of cable were subject to damage by being run into by other reels or by hitting stones when the reel was rolled over the ground.

Development of new reel

To prevent these cable injuries, a new reel (Fig. 6) was developed. A solid steel plate bolted to the spokes on the inside of the rim prevents denting by the narrow spokes. Bruising and denting by rolling were guarded against by inserting removable steel crossbars or by lagging under the rim tires so as to give a close casing entirely around the reel outside the outer turns of the cable. In other respects the standard reel construction remained, including the handling bail attachable to the extended axle trunnions on which the reel is mounted in the reel carriage.

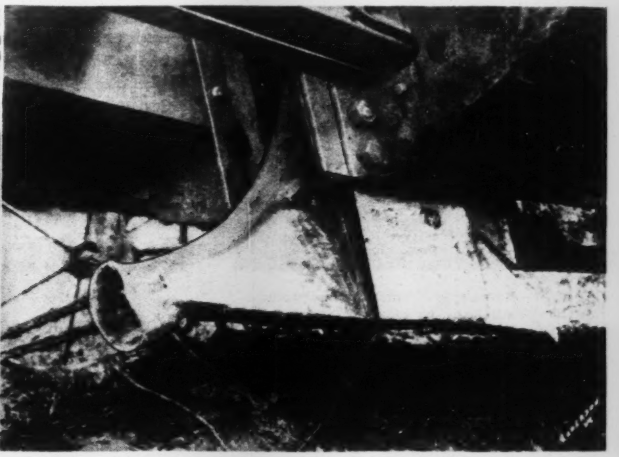


Fig. 5—Improved and much strengthened cable-laying plowshare used with carriage shown in Fig. 6.

With the new heavier reel and cable, the standard reel trailer or carriage called for changes that would make

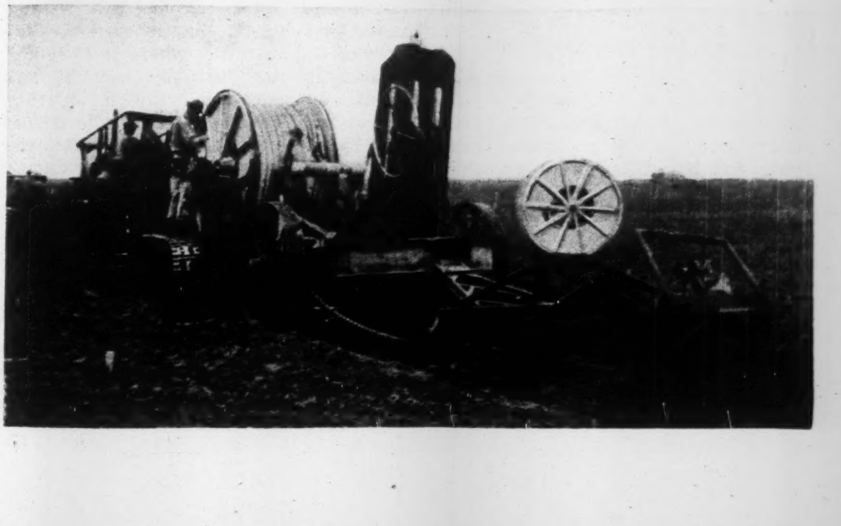


Fig. 6—Modern cable-laying train, showing improved cable reels and carriage, cable-laying plow and backfiller.

open-field travel safe and sure. The requirements pointed to crawler mounting and tractor haulage, and a reel train was developed, as shown by Fig. 2. The illustration shows two reel trailers in train, but ordinarily one trailer is hauled. The tractor and trailer train generally was limited to hauling on the work; for distant hauling from railway to the work the reels are loaded on trucks and transferred to the tractor equipment at the work.

Probably the greatest change is in ditching machinery. This originally was the wheel-type trench-excavator unit shown by Fig. 1. It was limited to reasonably easy digging. Where solid rock is encountered, drilling and blasting was and still is necessary. But for hard material between ledge rock and earth another device than the trench excavator was desirable. This led to the development of the cable-laying plow, which is the distinctive contribution of cable-laying operations to construction equipment.

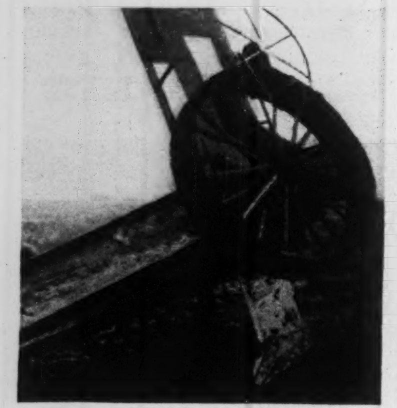


Fig. 7—Rooter-plow unit, which precedes cable-laying plow to ease its operation in exceptionally hard and tough ground.

The first plow developed was little more than a heavy steel point, wheel-mounted, which rooted a gash in the ground. This gash was then cleaned out for cable-laying by shoveling. Cable-laying followed, the tractor-reel trailer unit previously described being used.

Features of new equipment

The development of the trench plow marked broadly the end of the pioneer equipment stage of cable-laying plant. In this stage of the trenching, cable-laying and backfilling were successive separate operations with independent equipment units. Fig. 3 shows the trenching unit changed by substituting the trench plow for the wheel excavator, and Fig. 2 shows the cable-laying unit, which was usually operated, however, with one reel trailer. The backfilling unit was a standard crawler-mounted dragline-type backfiller regularly used on sewer and water-main construction. A distinctive construction feature was that a trench was dug (all the excavation taken out), the cable was then laid in the trench, and finally the excavated material was backfilled into the trench.

Modern equipment

The success of the original trench plow focused attention on the further possibility of using a plow for both trenching and laying cable. This combining of two operations in train led logically to the thought of completing the train by coupling to it the backfilling unit, particularly as, with the cable plow, very little material was removed from the trench, and backfilling required little rehandling of excavation. The train that was developed is shown by Fig. 3. As will be seen, the cable from the reel passes through a pipe, which is a part of the plow, into the ground as the plow advances. The backfiller coming behind scrapes back the small amount of earth thrown out of the trench.

The plow shown in Fig. 3 is a two-wheel carriage carrying a plow beam extending to the rear and carrying the plow. Fig. 4 shows the share. This plow, while performing its combined function perfectly, buried the cable only 20 to 22 in. deep, and 28 in. was more desirable; it also showed a tendency to "ride up" in hard material, and finally it lacked somewhat in ruggedness. The plow was then redesigned, as shown by Fig. 6, to have a very sturdy chassis carrying an upright frame, which in turn carries the share or plow proper and which can be moved up or down to the depth required. The plow share was also changed, as shown by Fig. 5, to a much stronger construction. To round out the plant, a separate rooter-plow unit was developed, as shown by Fig. 7. This is used in very rocky or tough ground to loosen up a ditch for the cable-laying plow to follow.

Development principle

The change from the pioneer units, shown by Figs. 1 and 2 with the separate backfiller, is a change from a succession of individual operations to a complete operation by a coordinated series of processes in train. The train in a single trip builds an underground cable line ready for manhole construction and testing. It has been developed by telephone engineers within a period of three years.

Machine Constructs Cable Line From Trench to Backfill

Trench excavator, backfilling conveyor and cable-reel carriage operating in train construct underground electric transmission line in one operation

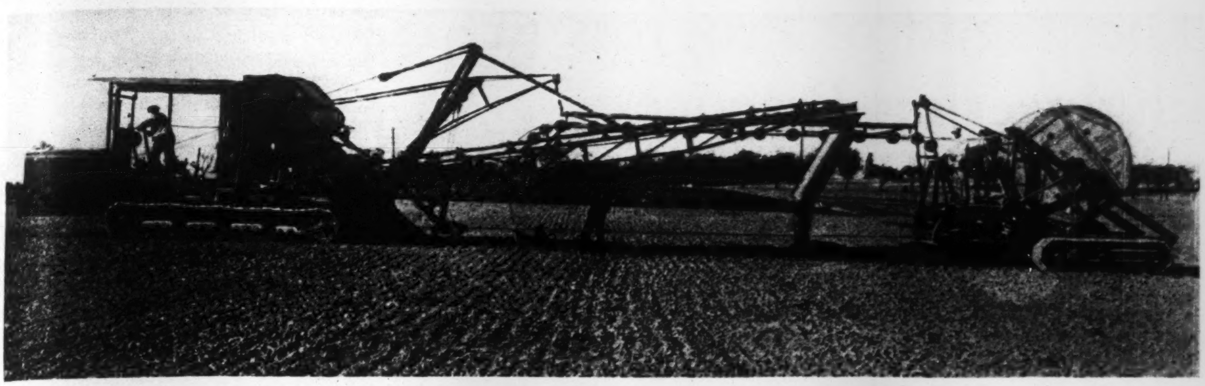
By Morris A. Robbin
Berlin-Wilmerschorf, Germany

A CABLE-LAYING machine designed to complete every detail of the work from digging the ditch to leveling the dirt over the buried cable has recently been built for the United Electric Works of Weissenfels-Zeitz, Germany.

The machine is composed of a ditch digger excavating to a width of 1.5 ft. and a depth up to 5.25 ft.; a belt conveyor carrying the dug-up earth to the rear of the machine, where it is redeposited in the ditch by a swinging spout; a cable truck drawn by the digger and serving also to roll down the loose earth; and the mechanism proper for laying the cable in the ditch. A controlling requirement in the design of the machine was that it must be able to travel over any kind of ground. This meant crawler traction for both the digger and the cable truck.

The ditch digger is carried between two crawler tracks. The track rollers are in cast-steel cages rocking on axles, which, through springs, carry the rigid steel main frame. By this device perfect adaptation to any unevenness of the ground and a uniform pressure on the soil of only 5 lb. per sq.in. are obtained. All running parts of the driving mechanism are in oil-tight housings, and a large proportion of them are hardened chrome-nickel steel, or other steel of extra-high tensile strength and elongation. Eight speeds are available, four for cable-laying and four for traveling. According to the speed chosen, the machine advances at a rate of 205, 260 or 304 ft. per hour while working, and it is able to cover 1.6, 1.75 and 2 miles per hour, respectively, while traveling. Backing speeds of 190 ft. for working and of 1.5 miles for traveling are available. A maximum of 2,450 ft. of cable may be laid in an eight-hour day.

The buckets first empty the soil into a short transverse conveyor. From there the soil drops into the main conveyor, which is suspended from the rear of the digger and is about 40 ft. long. By means of a swinging spout this redeposits the earth in the ditch at the other end. The cable passes its drum on the cable truck over a sheave track, which conducts it into the ditch directly behind the excavator buckets. In this manner about 14 to 16 ft. of



Machine train employed by the United Electric Works of Weissenfels-Zeitz, Germany, for trenching, laying and backfilling underground electric cable.

cable constantly remains exposed in the ditch, thus making it practicable to cover the cable with some means of protection when desired.

While the usual means of arresting one or the other of the tracks for purposes of steering are employed in the digger, a wholly different system was adopted for the cable truck. The rigid steel frame is carried by three crawler tracks, of which the front one is placed centrally in relation to the two rear ones, upon which the main load is concentrated. The rollers of each track are contained in a single steel cage that is centrally carried by, and rocks on, an axle. The front track, in addition, can be turned around a vertical axis and thus carries out the function of steering wholly by itself. The steering is done by means of a hand wheel from the driver's stand on the cable truck.

The sequence of operations in the laying of the cable is as follows: the digger, working slowly, excavates an open ditch about 20 ft. long, thus bringing the cable truck to the end of the ditch. The soil removed in this operation is deposited at the side of the ditch digger by the transverse conveyor. Next the full cable-drum is lifted to the truck by means of a winch on the latter. The cable is threaded over the cable conveyor sheaves in the direction of the digger and introduced into the ditch closely behind. From this point on the operations take place automatically.

The total expense of laying 3,280 ft. complete in this manner, allowing for payroll of crew, fuel and all necessary expenses and including 100 per cent for depreciation of the machine at the end of 220 miles as well as interest on the capital investment, would be only 320 marks, as against 1,800 to 1,200 marks for laying cable by hand. Five men are required with the machine, while more than 150 men would be needed to lay the same amount of cable during the same time by hand.

Dewatering and Incineration of Sewage Sludge Under Test at Chicago

WITH treatment plants in Chicago receiving the sewage of 2,000,000 people, constant efforts are being made to learn how to handle sewage in a more effective and economical manner. Many of the observations made in connection with the current experimental program of the Chicago sanitary district were outlined by Landon Pearce at the recent meeting of the Central States Sewage Association and the Illinois Association of Sanitary Districts at Rockford, Ill. One of the most interesting problems being studied is that of handling sewage solids. Developments are being sought in the direction of mechanical dewatering and incineration.

In digesting the mixture of activated sludge from the North Side plant and fresh sludge from the West Side plant it has been found that a moisture content of less than 94 per cent cannot be obtained in separate digestion tanks, even with the use of heat. A ropey sludge, different from that of an Imhoff tank, is produced.

A high-speed centrifuge, 4,000 to 5,000 r.p.m. with a bowl 5 ft. deep and not more than 20 in. diameter, has been developed to dewater 100 gal. per minute in an experimental way. Concentration of the sludge rather than making it into a cake is the objective. Tests on a small scale showed reduction of suspended matter in the effluent to 500 p.p.m. The question is mainly one of capacity and whether or not a sludge cake can be made at a sufficient output while maintaining the suspended matter in the effluent low enough to avoid the return of finely divided sludge. That was the experience in the Milwaukee centrifuge experiments.

Solids settled from sewage have a heat value in combustion about half that of Illinois coal. Experiments are under way, using vacuum filters and incinerators with activated and fresh sludge, with a view to eliminating digestion and sand drying beds. Ferric chloride (5 per cent) has been used as a conditioner. A cake of 80 per cent moisture has been produced at a rate of 3 lb. per square foot per hour. Different types of grates have been tried in the furnace, but a moving type seems satisfactory. The sludge burns fairly well with little odor, but the addition of coal has been found to be desirable. To determine the practicability of the process on a large scale, a plant to handle 20 tons of solids daily has been built. It comprises a vacuum filter, rotary heat dryer and a combustion furnace. The hot gases from the burning of the sludge pass back through the dryer. There is added 350 lb. of coal per ton of dry solids. An inert cinder-cake residue is left, resembling clinker with probably less than 1 per cent of organic matter. It is entirely without odor and quite suitable for filling.

The preparation of the solids before combustion to lower the moisture content is apparently worthwhile. If the moisture is about 70 per cent, the heat value of the solids may be sufficient to evaporate the moisture and burn up the sludge. In going from a vacuum filter to a rotary dryer or similar device, it seems practicable to carry the moisture down to about 20 per cent before incineration.

There is still the question of odor during incineration to investigate. This does not appear insuperable because it is planned to keep the temperature of combustion above 1,500 deg. F. If sludge is burned at low temperatures, around 300 to 500 deg., tests in the laboratory show that an odor problem will be presented. Evidence from the practice of garbage incineration points to the desirability of maintaining temperatures above 1,000 deg.

The Trend of Progress in Engineering Practice

By Herbert S. Crocker

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AMONG the many questions of current concern are two that affect every construction engineer profoundly, and every civil engineer to some extent. One is the sore question of engineer-contractor relations, the other is the future outlook for engineering practice.

Engineer-contractor relations

In the earlier stages of engineering practice in the United States, there seems to have been a well-defined line of demarcation between engineers and contractors. The contractor was a practical man in the most literal sense of the word; without especial pride in his important function; not overburdened with scruples as to the quality of his work so long as it yielded him a profit. If he found an opportunity to cut his costs, even though it meant a sacrifice of quality and workmanship, he seldom hesitated to take advantage of it. Indeed, this was sometimes a matter of pride with him.

The engineer on the other hand, both by education and technical training, held to a superior attitude. It was necessary and right that he should. As maker of the plans and specifications he was even more intimately acquainted with the detailed character of the work than was the owner himself. As the representative of the owner he also assumed the position of sole judge of the quality of materials and workmanship.

This situation led to a well-defined antagonism between the engineer and the contractor which has hardly redounded to the benefit of either. The contractor frequently saw in the engineer his enemy — the man whose principal aim, according to the contractor's point of view, was to keep a profit from being made. The engineer frequently saw the contractor, on the other hand, as an ever-present obstacle to good workmanship, a necessary evil who must be grudgingly endured.

In recent years this situation has changed to a considerable extent. The traditional antagonism still hangs on here and there, but for a number of excellent reasons it has begun to die out. The experiences of the World War, when everything was subordinated to the one goal, had much to do with this. For another thing, there have been marked changes in the personnel of construction organizations. The increasing size of construction projects began to reveal the inadequacies and defects of the old-fashioned "practical" contractor. The more far-sighted contractors began to find that the technical man had much to offer them; and then began the infiltration of qualified engineers into the contracting service.

Another important factor, of course, has been the laudable progress made by the Associated General Contractors in the promotion of higher standards of integrity and workmanship in construction.

Still another influence in the improvement of the status of contracting is the contractor's realization that without close cooperation no work of construction may be carried on efficiently or with complete satisfaction to any of the parties concerned. Contractors taken as a body are today more reliable, more efficient and more cooperative than ever before. Of course many "sharpshooters" are still to be found in the business and, on account of these, the unilateral contract is still a necessary club; but as a club it should be used sparingly and with discretion when a contractor is endeavoring to do good work.

The contractor has made his advances toward a more satisfactory relationship. Has the engineer done his part? The answer, of course, is that in the minds of many engineers a great gulf still exists between the two. Contracts and specifications are still written upon the assumption that this gulf shall not—or cannot—be bridged. Many engineers, as individuals, still entertain the old hostility.

The field engineer

One of the most difficult obstacles is the practice among engineers of placing upon their work as inspectors young engineers fresh from college, inexperienced, full of zeal, and with an abiding faith in the infallibility of plans and specifications. These become the rule and guide of their conduct, admitting no exceptions. Such faith in the infallibility of specifications is beautiful to behold, but hardly justified. If a perfect and all-inclusive set of specifications has ever been written, it has not been my pleasure to see it; and if so interesting a document exists anywhere, it should be suitably enshrined where it may become the object of engineering pilgrimages.

Decisions upon departures from specifications require a background of experience and mature judgment which young engineers cannot be expected to possess. The ideal inspector is capable of making fair decisions without the fear that the contractor may be deriving some hidden and diabolical advantage from them. A successful contractor usually has a fund of knowledge gained from practice—experience that stands him well in hand and that deserves the respect of an engineer. If relations between the contractor and the inspector are satisfactory, this fund of practical knowledge is available to the engineer at all times, and he should not be afraid or unwilling, to use it.

This is, in short, a plea for placing engineers of high caliber on the work and endowing them with greater powers of discretion than is now customary. It is a plea for recognition that the end of construction work is construction, and that the engineer charged with its immediate supervision is as important as the engineer engaged in design or remote supervision.

The future outlook

During the recent years of inflation engineers had difficulty at times in securing qualified assistants. Well-rounded men were not to be found in sufficient quantity. But that day is past—whether permanently or not no one can say. We have now entered into a period of smaller things. And though it may seem heresy to say so, I see in this new situation elements of possible benefit to the younger engineers.

Huge organizations with centralized authority, as we have found out, do not solve all our problems. With the breaking down of many of them and the dissolution of the mergers and combinations which brought them into being, construction is very likely to be resumed by smaller units. Each of these will contain all the elements that were contained in the larger. This means that instead of being swallowed up in a large enterprise and hence being forced into a one-sided development through overspecialization, the engineer may find himself in a more important and responsible position in a smaller concern. Engineering opportunities may be multiplied and diversified through local handling of construction. It may be that the field will open up once more for local consultants.

It must be confessed that the immediate outlook is not one to cheer the beholder. But that holds true not of engineering alone but of almost every field of activity. And unless we choose to share in the general discouragement, I see no reason for pessimism over the future of engineering. It is absurd to think of engineering as a decadent profession; in so vigorous a profession it is equally absurd to suppose that men of ability will not presently find congenial employment according to their talents. The high conception of professional responsibility which is held by engineers, combined with the indispensability of their services to our civilization, makes this inevitable.

Abstract from Colonel Crocker's presidential address to the Am.Soc.C.E. at the Yellowstone meeting.

Hoover Dam Penstocks Set Record for Size

Main headers to serve power units will be 30 ft. in diameter—Arc-welding specified for all longitudinal joints and stiffeners—Fabricating plant at site—Two new 37-ft. tunnels required

INSTALLATION of the penstock, control and discharge equipment at Hoover Dam, for which a contract was awarded to the Babcock & Wilcox Co. on July 9 (*ENR*, July 14, 1932, p. 60), involves the fabrication of 4,600 ft. of plate steel pipe 30 ft. in diameter, thought to be the largest ever made. According to the plans prepared in the Denver office of the Bureau of Reclamation under R. F. Walter, chief engineer, and John L. Savage, designing engineer, the shell thickness of this pipe, based on a working stress of 19,000 lb. per sq.in., varies from 1¾ in. to 2⅞ in. Other items of the contract include 1,900 ft. of 25-ft. pipe, 2,550 ft. of 13-ft. and 1,860 ft. of 8½-ft. pipe. According to the specifications, all longitudinal joints of the pipe are to be arc-welded, and stiffener rings are to be welded to the outside of the pipe shell; the ring joints may be welded or cold-pinned and calked. A fabricating plant will be established on the government railroad about a mile from the dam site.

Bids were taken on twelve alternate schedules, grouped under three general plans of pipe sizes, calling for one 30-ft., seven 13-ft. or three 17½-ft. pipes as headers in each of four tunnels. Under each of the three plans there were alternatives of having the government transport the pipes from the fabricating plant to landing platforms at the portals of construction adits leading to the tunnels, or to within 1 ft. of final location. Additional alternatives pertained to shipping of plates on government or commercial bills of lading. The contract as awarded provides for 30-ft. main headers, government transportation of pipe sections from the plant to the adits only, and shipment of steel on government bills of lading.

General conditions

A general plan of the project is shown in Fig. 1. At present the four 50-ft diversion tunnels are nearing completion. The two outer diversion tunnels, farthest from the river on each side, will remain as permanent spillway outlets. The two inner diversion tunnels will be utilized as penstocks, within which will be placed 30-ft. pipes leading from the intake towers. These will be known as the lower penstock tunnels. Above these tunnels and nearer the river two additional penstock tunnels, 37 ft. in diameter, yet to be driven, will also contain 30-ft. pipes. In these 37-ft. tunnels the space between the outside of the pipe and the rock will be filled with concrete, while the pipe within the larger tunnels will not be incased.

Opposite the power house four 13-ft. penstocks in 19-ft. tunnels lead from the main headers in each of the four tunnels to serve the turbines. The main headers continue below the takeoff of the 13-ft. pipes, though reduced in size to 25 ft. Those in the upper tunnels terminate in canyon wall outlets, each controlled by six 84-in. needle valves, while the lower tunnel headers terminate in a concrete plug containing six 72-in. needle valves for discharge control.

Construction program and schedule

The government has provided space for a fabricating plant and a 1,000-ft. railroad siding about a mile from the terminus of the railroad on the canyon rim above the dam site. Fabricated pipe sections will be transported by the government from the plant to platforms at the portals of adits, to be driven from the canyon walls to each of the four tunnels shown in Fig. 2. A cableway with a lowering capacity of 135 tons will be installed to handle the pipe sections from the end of the railroad to the landing platforms at the adits near the bottom of the gorge. The pipe contractor must move the pipe sections from the portals of the adits to final location within the tunnels and provide temporary supports.

Permanent supports, anchors and concrete incasement will be furnished by the government. These permanent supports for the large pipes in tangent sections of the lower tunnels consist of 15-in. steel columns on concrete pedestals, the columns being welded to the stiffener rings of the pipe. Provision for expansion is made by inserting two layers of graphited sheet packing be-

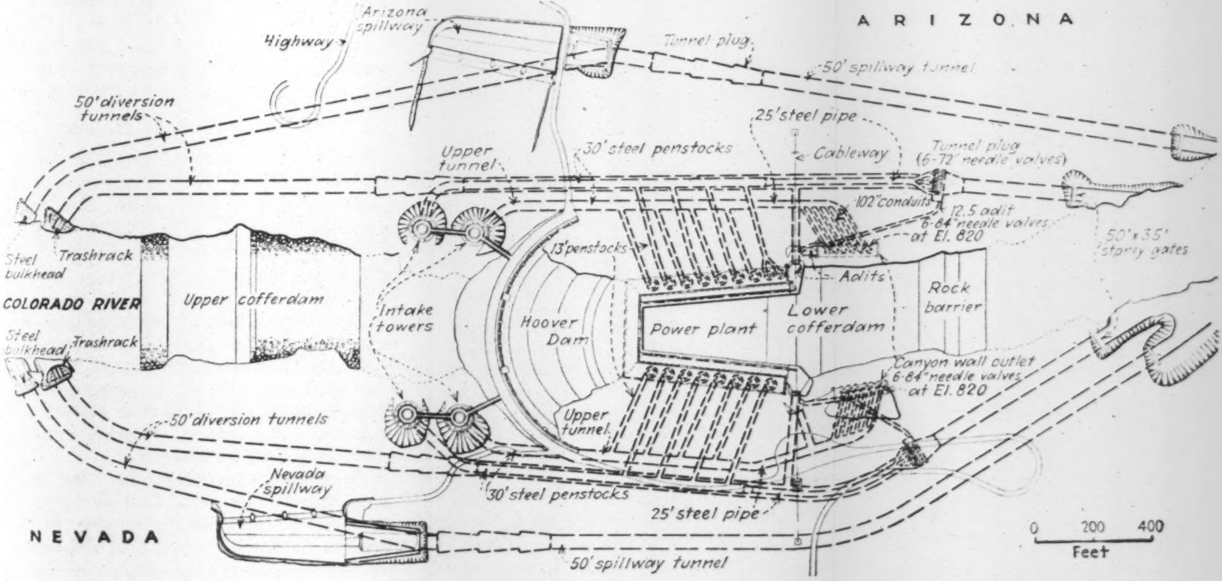

Arizona spillway
Highway
Tunnel plug
50' spillway tunnel
A R I Z O N A
50' diversion tunnels
25' steel pipe
Upper tunnel
30' steel penstocks
Cableway
Tunnel plug (6-72" needle valves)
102" conduits
12.5 adit
6-84" needle valves at El. 820
50'x35' stoney gates
Steel bulkhead
Trashrack
13' penstocks
Adits
Rock barrier
COLORADO RIVER
Upper cofferdam
Intake towers
Hoover Dam
Power plant
Lower cofferdam
Steel bulkhead
Trashrack
Canyon wall outlet
6-84" needle valves at El. 820
Upper tunnel
50' diversion tunnels
Nevada spillway
30' steel penstocks
25' steel pipe
NEVADA
50' spillway tunnel
0 200 400
Feet

Fig. 1—General plan of Hoover Dam project, showing arrangement of penstock system. Two of the existing 50-ft. diversion tunnels and two 37-ft. penstock tunnels, as yet not driven, will carry 30-ft. diameter steel pipe headers.

tween the pedestal cap plate and the column base plate, the latter plate having slotted holes for anchor bolts. Concrete saddles will be used in place of steel columns for pipe supports in curved alignment.

Several sets of anchors will be installed in the 30-ft. and 25-ft. pipe lines to resist compressive stresses due to temperature changes. One girth joint between each pair of anchors will be left temporarily unconnected during erection, the connection to be made at a time when the temperature of the metal is 50 deg. F., a condition that might require artificial cooling. The anchor sets consist of hooked rods fastened to special anchor rings on the pipe and buried in the concrete lining of the 37-ft. tunnels and in heavy concrete anchor rings, completely filling the bore in the lower tunnels.

Construction Schedule—Specifications require work to be started within 30 days after the contract is awarded. In all four tunnels the first 40 ft. of pipe below the intake towers must be installed within 580 calendar days. The upper Nevada tunnel is specified for completion first, the valve conduits and manifolds in the canyon wall outlet works to be completed in 695 days, and the remainder of headers and penstocks in 880 days, or by Jan. 1, 1935. The upper Arizona penstock must be entirely completed in 1,250 calendar days. The time for completion of both the lower tunnel installations has been set at 1,975 calendar days, or by March, 1938.

Pipe fabrication and testing

Fabrication of all pipe above 13-ft. diameter must be done at the field plant, and it is expected that the plates for these larger pipe will be shipped flat from the mill. The 13-ft. and smaller pipes may be fabricated at the contractor's plant at Barberton, Ohio. All fabrication must be in accordance with requirements of "Rules for Fusion Process of Welding," class I, of the A.S.M.E. boiler construction code, unfired pressure vessel section. Plates must be curved to practically true circles, with the direction of bending parallel with the direction of rolling of the plate. Not more than three longitudinal joints will be permitted in the 30-ft. and 25-ft. diameters. Pipes 13 ft. and smaller will have but one longitudinal joint. Longitudinal joints must be staggered in adjacent sections. Girth joints may be welded and strain relieved, or double-pinned outside butt straps may be used, cold-pinned for plates 1 in. and more in thickness.

Welding—The welding of all longitudinal joints and shop-welded circumferential joints must be done with automatic welding apparatus by a process that will exclude air from the metal while in its molten state. All welded joints must be of a type that will produce complete fusion with the plates. Each deposited layer of metal must be thoroughly peened.

Weld Tests—One weld-test specimen must be provided for each fabricated length of pipe. In test, welded joints must show 100 per cent efficiency. The entire length of each welded joint is to be inspected by means of X-rays. This applies to welds made in the tunnels as well as at the plant.

Hydrostatic Tests—All wye branches and valve manifolds will be subject to a hydrostatic pressure test 50 per cent greater than expected working pressures. Upon completion of each tunnel system the penstocks will be filled to at least the elevation of intake tower bases for a hydrostatic pressure test.

Protective Coating—Just before being taken into the tunnels, the pipe will be sandblasted to bright metal on all inside surfaces and thoroughly cleaned on the outside surfaces and given a primer coat of water-gas coal tar. After erection, all surfaces will be given a cover coat of coal-gas tar, applied hot.

Double sections 24 ft. long

The Babcock & Wilcox Co. announces that the largest pipe sections will be made up of 12x35-ft. plates, the maximum size possible to roll with existing steel-mill equipment. As each plate will weigh about 25 tons, only two can be shipped on one car from the mills to the dam. Three such plates will form one piece of pipe 12 ft. long. Two pieces will be shop-fabricated to make one section 24 ft. long, weighing 150 tons, to be handled from the plant to the tunnels. The entire tonnage involved is estimated at 55,000 tons.

The formal contract for the work was signed July 18 at Denver by S. O. Harper, acting chief engineer of the Bureau of Reclamation, and officials of the Babcock & Wilcox Co.

Fig. 3—The heavy pipes will be carried by steel column supports in tangent sections and by concrete saddles on curves.

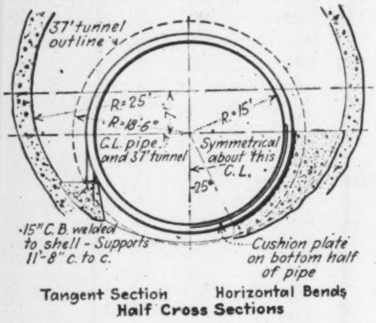
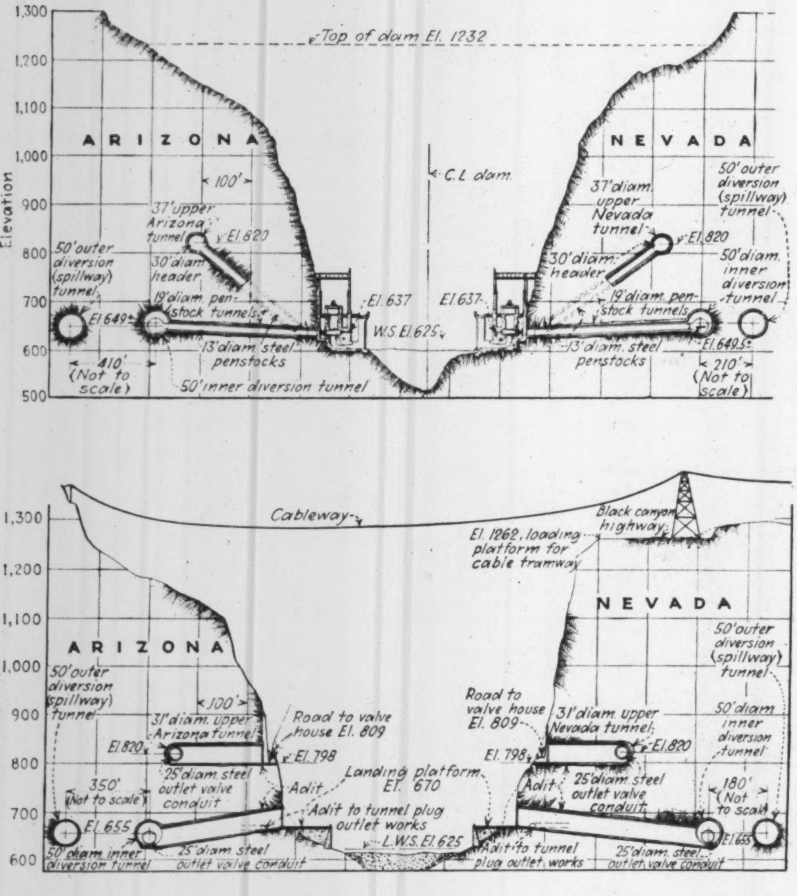

37' tunnel outline
R=25'
R=18'-6"
7'
R=15'
C.L. pipe and 37' tunnel
Symmetrical about this C.L.
25°
15" C.B. welded to shell - Supports 11'-8" c. to c.
Cushion plate on bottom half of pipe
Tangent Section
Horizontal Bends
Half Cross Sections

Fig. 2—Cross-sections of Black Canyon Gorge at the power house (above) and at the location of construction adits (below) through which the pipes will be taken into the tunnels. The government will handle the pipe sections from the top of the gorge to the landing platforms, shown in lower section, by a 135-ton cableway spanning the canyon.


1,300
1,200
1,100
1,000
900
800
700
600
500
Elevation
Top of dam El. 1232
ARIZONA
NEVADA
100'
C.L dam
37' upper Arizona tunnel
El. 820
30' diam. header
50' outer diversion (spillway) tunnel
19' diam. penstock tunnels
El. 649
El. 637
W.S. El. 625
13' diam. steel penstocks
410' (Not to scale)
50' inner diversion tunnel
37' diam. upper Nevada tunnel
El. 820
30' diam. header
50' outer diversion (spillway) tunnel
50' diam. inner diversion tunnel
19' diam. penstock tunnels
El. 637
13' diam. steel penstocks
El. 649.5
210' (Not to scale)
Cableway
Black canyon highway
El. 1262, loading platform for cable tramway
ARIZONA
NEVADA
50' outer diversion (spillway) tunnel
100'
31' diam. upper Arizona tunnel
Road to valve house El. 809
El. 820
El. 798
25' diam. steel outlet valve conduit
Adit
Landing platform El. 670
350' (Not to scale)
Adit to tunnel plug outlet works
El. 655
L.W.S. El. 625
50' diam. inner diversion tunnel
25' diam. steel outlet valve conduit
Road to valve house El. 809
31' diam. upper Nevada tunnel
El. 798
El. 820
Adit
25' diam. steel outlet valve conduit
50' outer diversion (spillway) tunnel
50' diam. inner diversion tunnel
180' (Not to scale)
El. 655
Adit to tunnel plug outlet works
25' diam. steel outlet valve conduit

Developing the St. Lawrence for Shipping and Power

Treaty announcement recalls ten years of planning of works to carry ocean shipping to the Great Lakes and to utilize the power of the International Rapids

THE OFFICIAL announcement by President Hoover on July 18 that the terms of a treaty for the development of navigation and power on the St. Lawrence River have been signed by the negotiators for Canada and the United States gives promise of approaching realization of the magnificent vision of bringing ocean commerce to the Great Lakes. Plans for this great waterway development have been the subject of repeated studies during a dozen years. Each of these has provided additional facts and contributed a step to the development of a general plan. As the studies have ment. As the contributing studies have been completed they have been summarized in the issues of *Engineering News-Record*, covering a decade of publication. In the light of the latest and most definite development of a treaty agreement, it appears desirable to review briefly the activities that have preceded in so far as they relate to the engineering problems and the proposed methods of solving them. The general provisions of the treaty are summarized in the accompanying statement. They are based on a final report of the joint board of engineers, dated April 9, 1932.

The St. Lawrence River between Lake Ontario and Montreal harbor has a length of 182 miles and a fall of 224 ft. This 182 miles of river is divided into five sections.

Sections of the river

1. The Thousand Islands section, embracing the deep lake-like reaches of the river for 67 miles from Lake Ontario to the first swift water at Chimney Point 3 miles downstream from Ogdensburg, N. Y.
2. The International Rapids section, embracing the 48 miles of swift water between Chimney Point and the head of Lake St. Francis.
3. The Lake St. Francis section, extending 26 miles through that lake to deep water at its foot.
4. The Soulanges section, embracing the 18 miles of rapids and shoal water from Lake St. Francis to Lake St. Louis.
5. The Lake St. Louis section, including the lake and the rapids and shoals 23 miles to Montreal harbor.

The first two sections lie along the boundary between New York and Ontario; the others are in Quebec. Improvement of sections 1 and 3 is solely a problem of excavating channels for navigation. The other three sections can be developed for power as well as navigation.

Briefly, all studies by international boards have embraced power and navigation developments for all five sections but have centered on the International Rapids section. The study of the St. Lawrence Power Development Commission of New York was confined to the International Rapids section. This is largely true also of the studies and plans developed by the Hydro-Electric Power Commission of Ontario and of various individual engineers and power companies that have submitted plans to the international and state commissions for consideration. In the present review the plans for the International Rapids section alone are considered, as this section includes the major engineering problems.

The general characteristics of this section are: The section is 48 miles long from Chimney Point to the head of Lake St. Francis. The river here runs in a succession of rapids beginning with Galop Rapids and ending with Long Sault Rapids, with the Rapide Plat about midway between, as shown on the accompanying map. The total fall at mean river stage is 92 ft., of which about one-third is in the upper 18 miles above the foot of Rapide Plat at Ogden Island.

Plan of 1921

Although the possibilities of a comprehensive project for developing power and navigation on the St. Lawrence had been discussed informally by both Canadians and Americans, the first formal

Principal Provisions of St. Lawrence Treaty

The principal provisions of the St. Lawrence waterway treaty signed July 18, 1932, are the following:

The two-stage project adopted is to have a 30-ft. depth in works and a 27-ft. channel in the reaches.

Water for power purposes in the 48-mile International Rapids section is to be divided equally between Canada and the United States, each nation having right of disposal over its power.

The level of the Great Lakes is to be maintained by compensating works and to adhere to the Supreme Court ruling for 1,500 cu.ft. per second diversion for the Chicago drainage canal. Two escape clauses provide for temporary increase of this diversion on proposal of the United States subject to arbitration if Canada objects, and for permanent increase by action of the International Joint Commission.

In the International Rapids section two dams are to be constructed, one at Crysler Island, east of Ogdensburg, N. Y., and one at Barnhart Island, near Cornwall, Ont., both locations subject to change.

One power house each on either side of the International Boundary at the two dams are provided, with navigation canal and lock on Canadian side at Crysler Island and side canal and two locks on American side at Barnhart Island. The installed hydroelectric power to be generated at Crysler Island is 592,960 hp.; and at Barnhart Island, 1,607,000 hp. or about 1,100,000 hp. for each country, derived from International Rapids section.

Dam construction and river work in International Rapids section, exclusive of power superstructures and machinery, is to be done under supervision of a temporary International Rapids Section Commission.

Costs are to be divided about equally between United States and Canada with allowances to be made for work already done.

The total cost from Great Lakes to Montreal is estimated at $543,429,000. Allowing for work already done, the new cost is to be $258,453,000 for the United States and $142,976,000 for Canada. Actual costs to the two governments are to be reduced through payments of State and Provincial Governments for power.

The United States is to pay for riverworks in the International Rapids section, two-thirds of which will be on the American side, with Canadian workers and material used on Canadian side and American workers and material on the American side.

Canada is to do the necessary work in the Thousand Islands section below Oak Point, at the foot of the islands, and the United States is to do the work in that section above Oak Point. Canada is to make the necessary improvements in the Lake Francis, Soulanges and Lachine areas.

The rights of navigation under existing treaties are to be maintained; it is estimated that construction will require from seven to ten years.

official attempt to arrive at a meeting of minds was made in 1919.

In the fall of 1919 the Canadian government accepted the invitation of the United States government to undertake a joint investigation of the improvement of the St. Lawrence River for deep-draft vessels in the interest of both countries and for the most beneficial use of the waters. To the International Joint Commission were referred the questions of the economic advantages to be derived from the improvement, of the traffic that is likely to be carried upon the proposed route, of the apportionment of capital cost, of cost of operation and maintenance of the improvements.

To facilitate the work of the commission, each government appointed an engineer for the purpose of acquiring data and of preparing complete outline plans for and estimates of the cost of the improvement. W. A. Bowen, chief engineer, Department of Railways and Canals, was named by the Dominion of Canada; and Col. W. P. Wooten, Corps of Engineers, U. S. Army, was designated by the United States government. The joint report of the engineers was submitted to the commission on July 1, 1921. A full abstract of the salient features of the report was published in *Engineering News-Record*, Sept. 8, 1921, p. 402.

Briefly, the improvement proposed was the construction of a dam in the Long Sault Rapids that would raise the water level, creating a pool reaching into the Rapide Plat at Ogden Island. At Ogden Island a second dam was to be constructed, which, with suitable channel enlargements, would carry navigation through the upper part of the section. A canal along the Canadian shore, 8 miles long, with two locks, was to carry navigation from the pool formed by the lower dam back to the river at Cornwall. A power plant, with a 74-ft. head and of 1,777,000 hp. at the first dam at Barnhart Island, and a second power plant of 60,000 hp. at the head of Long Sault Island were contemplated. The dam at Ogden Island was not planned to develop power. The commission recommended that further study be made by a joint board of the two countries.

Plan of 1926

In the spring of 1924 the United States government appointed a national committee under the chairmanship of Herbert Hoover, Secretary of Commerce, designated as the St. Lawrence Commission of the United States, and subsequently the government of Canada appointed a National Advisory Committee under the chairmanship of George Perry Graham, Minister of Railways and Canals, to advise the government on matters relating to the improvement of the St. Lawrence. These two bodies agreed that the two governments should follow the recommendations of the International Joint Commission made in 1921 that a joint board of engineers representing the two countries should be constituted to review the plan formulated in the Bowden-Wooten report of 1921 and to report on additional related matters. The board as appointed consisted of Col. Edgar Jadwin, Col. William Kelly and Lieut.-Col. George R. Pillsbury, representing the United States, and Duncan W. McLachlan, of the Department of Railways and Canals, Oliver O. Lefebvre, chief engineer, Quebec Streams Commission, and Brig.-Gen. Charles H. Mitchell, representing the Dominion of Canada. This board made its report to the two governments on Nov. 16, 1926. An abstract of the report was published in *Engineering News-Record*, Dec. 2, 1926, p. 906. Two plans were submitted by the board. The first was for a single-stage development of power, with a dam in the vicinity of Barnhart Island at the foot of the reach but with control gates at Galop Island at the head of the reach, except for 450 ft. across the channel provided for navigation. The second plan was for a two-stage development with two pools, the upper pool formed by a dam and power house at Ogden Island, and the lower pool by a dam and power house at Barnhart Island.

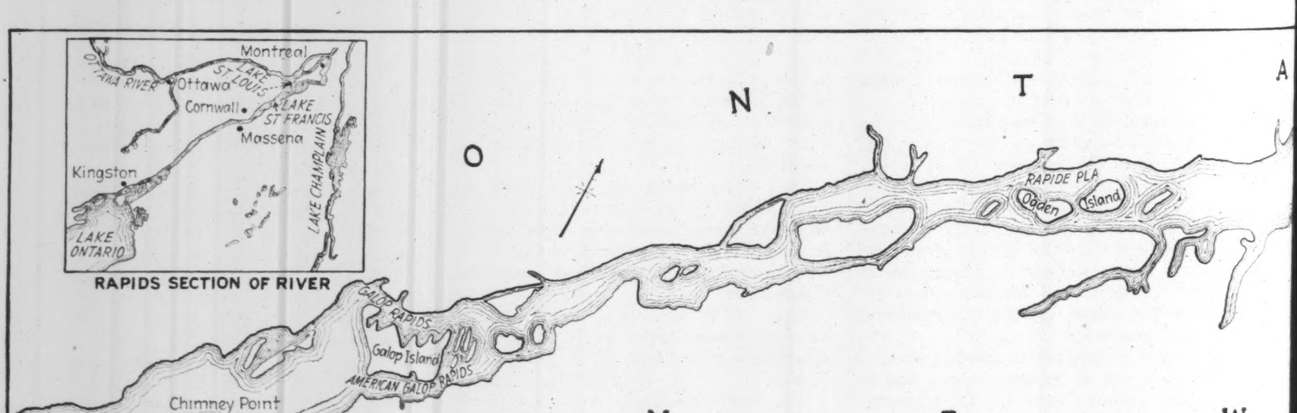
Navigation was provided for as follows: with the single-stage development, navigation had a free channel to Barnhart dam and passed the dam by an American canal and two locks to a free channel to Lake St. Francis. With the two-stage plan, there was a lock at Ogden Island as well as the canal and locks at Barnhart.

It was figured that the single-stage plan would develop 2,326,000 hp. at a cost of $253,000,000, and that the two-stage plan would develop 1,808,600 hp. at Barnhart and 406,400 hp. at Ogden Island, or a total of 2,215,000 hp., at a cost of $264,600,000. The American engineers favored the single-stage plan because of the $29,600,000 less cost and because it afforded better navigation by eliminating one lock. The Canadian engineers favored the two-stage plan because it could be constructed in two parts and power could be developed and marketed from the upper plant ahead of the completion of the lower plant, because it reduced the area flooded by 10,000 acres and because it was considered to give better control of the river.

New York State plan

In 1930 the New York State Legislature created the St. Lawrence Power Development Commission to consider a plan of developing power by a state-controlled agency. This body presented its report on Jan. 15, 1931. Its engineering board consisted of Lieut.-Gen. Edgar Jadwin, U. S. Army, retired; Oscar G. Thurlow, vice-president, southern division, Allied Engineers, Inc., Birmingham, Ala.; Silas H. Woodard, consulting engineer, New York; and Frederick Stuart Greene, superintendent of public works of New York State.

The report favored a single-stage development with a dam at Massena Point, somewhat below Barnhart Island. It



Sketch map of International Rapids section of the St. Lawrence River, showing principal rapids and islands considered by various commissions as possible sites for dams and power plants.

recommended building the dam in two steps, the first to develop a head of 50 ft. producing 600,000 hp. at an estimated cost of $80,000,000. Subsequently, as more power is required, the dam can be raised to develop the full head of 85 ft. at an additional cost of $91,000,000. The completed plant will produce 2,200,000 hp. The board believed that this plan would cost $70,000,000 less than the double-stage development and would produce more power. It also states that its project would flood less land than the single-stage development proposed in 1926, one of the major objections to that plan.

The total cost for full power development, including work necessary to coordinate power and navigation, was estimated at $171,000,000, including interest during construction. The works necessary for navigation alone were estimated to cost an additional $60,000,000, inclusive of interest during construction.

One major advantage claimed for the plan was that the power houses can be built on dry land rather than in the river, as proposed in the 1926 plan. However, as Massena Point is on the American side, some objection was expected to be raised to building the Canadian power plant on the American side. To meet this objection, the board considered a Massena Point-Barnhart Island plant. It will not produce quite as much power. A control dam at Galop Island was recommended.

The dam proposed by the board consisted of earth dikes on high ground, a rockfill section across the main river near the middle of Barnhart Island and also across the channel to the north of Barnhart Island.

Other plans

During and between these official investigations various quasi-public agencies and private engineering and power development corporations have come forward with development plans but these were discarded for the plans proposed.

Letters to the Editor

Low-Cost Apartment Building

In connection with the design of the $6-a-room apartment building described in our issue of July 7, p. 9, the Portland Cement Association states that the study was carried out by L. H. Corning, engineer, in cooperation with W. W. Harding, architect, and a group of contractors and equipment manufacturers. The last paragraph of the article should be corrected accordingly.

Employment Through Federal Building of New Factory Towns

Sir—The President does not feel that a vast program of public works should be undertaken under present conditions because most public works are luxuries and are not self-liquidating. The following program should be equally helpful to general business revival and yet not open to the same objection.

It is that the federal government should direct and finance the building of new towns and small cities, including the factory buildings necessary to support their inhabitants. Some of the factory buildings might be designed for any general manufacture, but most should preferably be specially designed for individual manufacturers, who would pay for them on deferred payments.

Of the present over-supply of manufacturing space, much is quite unfit for modern manufacture, and much of it is poorly located geographically for its output. I venture the assertion that at least 25 per cent of our moderately successful manufacture has been only moderately successful because carried out in old and unsuitable buildings. A high authority on such subjects also recently stated that in his opinion not 10 per cent of manufacturing buildings are located properly for their markets or supply of raw material.

Many manufacturers, handicapped with old buildings and poor locations, would jump at an opportunity to drop the old plant and obtain a new and up-to-date one for which they could pay out of the increased profits of future output. Reduced taxes, the advantage of ideal homes for their employees, and the savings resultant from improved lay-out would make their deferred payments on the plant easy to meet and justify the discarding of old buildings.

My proposal may appear radical and with little in the way of precedent to justify it. However, it differs little except in its scope from work of the Reclamation Service, an undertaking that few would have courage to criticise. WALTER S. MOODY.

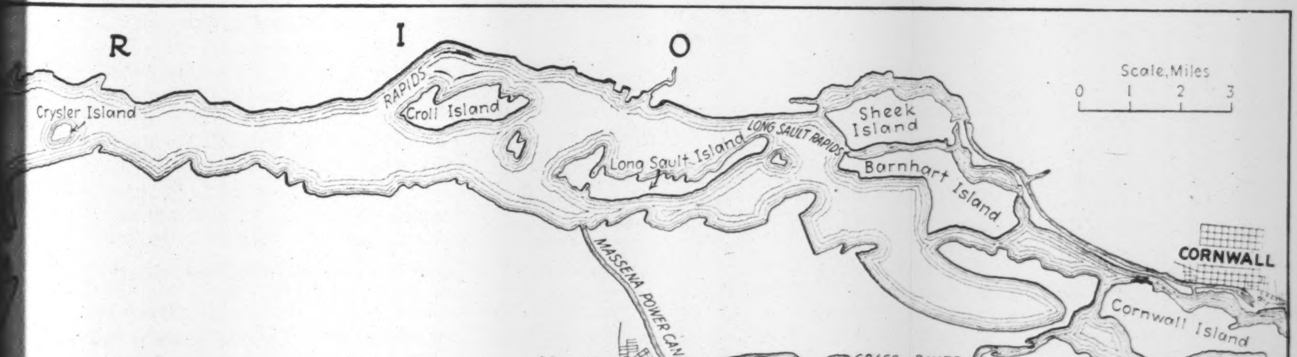
Pittsfield, Mass.,
July 13, 1932.

Chinese Water Tank

Sir—The letter in *Engineering News-Record*, April 28, 1932, p. 630, undoubtedly refers to the water tank for the plant of Yenching University, located a short distance outside of Peiping, China. Contrary to the opinion implied in the letter, that tank was designed by an American architect whose name I do not know; and it was constructed by an American civil engineer whose name I do know, Karl Hildebrande, now with the Manila Electric Co. at its Botocan hydro-electric plant in central Luzon.

The architectural motif of the entire university plant is Chinese, as is also that of the Peking Union Medical College (Rockefeller Foundation) in Peiping itself; but that does not make either of them any the less American in design or construction.

M. R. ARICK,
Oriental Consolidated Mining Co.
Hokuchin, Chosen (Korea),
June 12, 1932.



Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineer's Library

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Corporate Pyramids

THE HOLDING COMPANY: Its Public Significance and Its Regulation—By James C. Bonbright, Professor of Finance, Columbia University, and Gardiner C. Means, Columbia University. Cloth; 6x9 in.; pp. 398. Published by McGraw-Hill Book Co., New York. $4.

CORPORATE PYRAMIDS of the twentieth century, more generally known as holding companies, are described and analyzed searchingly by Messrs. Bonbright and Means in their large book on the subject. Industrial, utility, railroad and bank holding companies are considered, with most space given to utilities and railroads. In each section there is first a historical review. Then comes a description of the holding company in that group and a well-balanced discussion of its advantages and disadvantages for that utility. Throughout, the authors urge the imperative need of state and federal control of holding companies for the protection of the patrons of subsidiary companies and of the investing public. Possible methods of control are considered, with due regard for the difficulties involved. The historical completeness of the volume would have been increased and the discussion at several points enriched had the authors not ignored waterworks holding companies, one of the oldest types, now operating widely, although chiefly in relatively small cities because of the general prevalence of municipal ownership of waterworks today.

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Washington—The City

PLANNING AND BUILDING THE CITY OF WASHINGTON—A collection of monographs by architects and engineers; edited by the late Frederick H. Newell. Cloth; 5x8 in.; pp. 252; numerous halftones and charts. Published for the Washington Society of Engineers by Ransdell, Inc., 810 Rhode Island Ave. N.E., Washington, D. C. Standard edition, $2; de luxe edition autographed by F. H. Newell, $3.

THE LAST work of the late Frederick H. Newell was for his fellow engineers, that of editing this record of what engineers and architects have done in the planning and building of the City of Washington and what they are still doing in the work of maintaining its streets, parks and utilities. The book is the contribution of the Washington Society of Engineers to the George Washington bicentennial. It begins its record of the city with George Washington's own plans for it and carries the record through to the present time, describing the early planning in detail and selecting from the subsequent history those subjects of special interest to engineers such as the difficult foundation work involved in building the Washington monument. Considerable space is given to engineering activities of the federal government and to the scientific institutions of the city. Each chapter is written by an authority on the subject covered.

◆

New Mode of Approach

RECENT TECHNOLOGICAL DEVELOPMENTS AND THE MUNICIPALLY OWNED POWER PLANT—By Paul Jerome Raver, Research Associate, Institute of Economic Research. Paper; 8x10 in.; pp. 87; tables and diagrams. $1.50 from Institute for Economic Research, 337 South Chicago Ave., Chicago.

A NEW mode of approach to the study of municipal ownership has been made by Paul J. Raver in his review of the influence of engineering factors on the numerical growth and decline of municipally owned electric-light and power plants. For the United States, for groups of states and for individual states, the author presents and discusses statistics for the 28 years from 1903 to 1930, classified by generation of their own or purchase of power, and by type and size of power plant used—steam, gasoline and oil. Interwoven with the technical comments on the reactions of these factors on municipal ownership are remarks on still other factors increasing or retarding municipal ownership, some of which favor growth rather than decline, both in number of plants and in their power capacity. The basic data were taken from the annual issues of the "McGraw Central Station Directory." These were sent to "plant managers and city clerks for checking and correction." Other sources of information, including replies to a questionnaire, were utilized. The monograph is an interesting and valuable addition to publications on municipal ownership.

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In Three Languages

HOYER-KREUTER TECHNOLOGICAL DICTIONARY: Second volume; English-German-French — Sixth completely revised edition. Cloth; 8x11 in.; pp. 767. Published by Julius Springer, Berlin, agent in U. S., The Industrial Press, 148 Lafayette St., New York City. Price, three volumes $55; two volumes $37.50; one volume $19.50.

TWO of the three completely revised editions of the Hoyer-Kreuter Technological Dictionary are now off the press. The first one, the German-English-French volume, came out in April (*ENR*, June 16, p. 866), and the third will be out later in the summer.

The arrangement of these dictionaries is unique, the corresponding word in each language being given thus: *Consulting engineer*—beratender ingeniör—ingénieur-conseil. In this way, especially in the case of words having no exact equivalent in one of the other languages, the searcher for a corresponding word is aided by having its equivalent in the third language before him.

Each volume covers about 100,000 key words in each language.

◆

Channel Hydraulics

Reviewed by Fred M. Scobey

Member Special Committee on Hydraulics, American Society of Civil Engineers, Berkeley, Calif.

HYDRAULICS OF OPEN CHANNELS—By Boris A. Bakhmeteff, professor, Columbia University; formerly professor, Polytechnical Institute, Petrograd, Russia. [Engineering Societies' Monographs]. Cloth; 6x9 in.; pp. 329; diagrams and tables. Published by the McGraw-Hill Book Co., New York and London. $4.

"WITH REGARD to hydraulic design as envisioned by the civil engineer, the fact is that uniform movement scarcely ever occurs in actual practice." With these words in his preface Dr. Bakhmeteff shows a practical knowledge of *water* and supports this throughout his work with a demonstration that he also has an academic mastery of *hydraulics*. The two have not always gone hand in hand. The engineer—civil, mechanical or electrical—dealing with design or operation of open channels, particularly canals, will welcome the clear diagrams, practical examples and theoretical analyses of the numerous cases of non-uniform flow so often found in practice but so seldom understood.

Prof. Bakhmeteff divides his book into three parts: (1) theory of gradually varied flow; (2) practical applications; (3) hydraulic jump. In part I he develops and explains several effective tools in the forms of graphic curves and differential equations in mild degree. The measure of channel conveyance is established as $K = aC\sqrt{R}$ in the Chezy equation, $v = C\sqrt{R}\sqrt{s}$ multiplied by a in the continuity equation, $Q = av$. The conveyance curve shows K as a function of water depth y. Throughout the book K is much in evidence. The second tool is the M curve where $M = a\sqrt{a/b}$, another function of y, closely associated with critical functions such that the critical slope becomes $g\dfrac{M^2}{K^2}$ and the critical discharge curve $Q_c = \sqrt{gM}$. The critical velocity $v_c = \sqrt{gd_m}$ is already familiar. The curve of specific energy, or energy content as King and others have put it, shows the alternate stages faster than critical, slower than critical and the combined stage at the critical.

velocity, possible for any given Q with variable quantities of total energy $y + h_v$. This curve is shown in the form made familiar by Casler some three years ago rather than that used by Hinds in 1920.

In all varied flow of course there is a constant investment or recovery of velocity head. Much erroneous computation has resulted from ignoring this fact. By means of a "kinetic flow factor," developed in terms of M as mentioned above, the author works this influence into his formulas and problems. The character of surface in all varied flow is shown to be intimately connected with critical depth. For general solution of backwater problems the author offers an exponential function of depth for use with his measure of conveyance K. All reasonable values of the "hydraulic exponent" are tabulated, and typical values of the exponent for various shapes are developed. To the reviewer this is a new and most acceptable device. It appears to reduce the use of the trial method for the solution of flow problems. For rectangular channels the usual recourse to flow per unit width is adopted. Many of the channels of appreciably variable flow, especially in the West, are of circular or modified hydrostatic-catenary shape. For these, q per unit width does not appear proper. For the parabola Tolkmitt's solution is given.

In part II numerous problems in canal and structure design utilize the principles explained before. Here the author displays an intimate knowledge of field requirements. Ordinary canal delivery problems are followed with those for canals without bottom slope and chutes with steep slope. Entrance conditions are covered in one chapter, but the more difficult and less understood problems attached to outlets do not get the attention they deserve.

Part III is devoted to the hydraulic jump. A phenomenon dismissed with a paragraph in American textbooks of twenty years ago, the jump is now appreciated as a thing to be considered in all flow approaching the critical. Formerly thought of as occurring only at the toes of overpour dams, we find it in unexpected places in canals or below gates, or at transition points between two types of channel. It is now fully appreciated as a control point, for use in measuring water. Apparently the author was fully conversant with its possibilities at the time his Russian work appeared, some 20 years ago.

Withal, this is a remarkable book. It is bound to be extensively quoted in future. Some additional treatment would be welcome—the effects of sharp curvature in canals; the reason for heavy stationary waves, or rapid bore waves; the effect of entrained air in steep chutes, where Q does not equal av; the effect of back eddies at outlet transitions from the high-velocity type of canal, where again Q does not equal av. Typographical errors in the text and drawings should be corrected in a future edition. Unless the reviewer is much mistaken the demand for this book will warrant such an edition in the near future. The book will be found to be much more than the usual "contribution to engineering literature."

Miscellaneous Notes on Booklets and Reprints

FLOW OF AIR through circular orifices in thin plates, a continuation of a study of the flow of air through orifices, is the subject of Bulletin 240, published by the Engineering Experiment Station, University of Illinois, Urbana, Ill. (Price 25c.)

SYDNEY HARBOR BRIDGE is the subject of a booklet made up of reprints from *The Engineer*. The reprint is freely illustrated with halftones and line drawings. (2/6d., *The Engineer*, 28 Essex St., London, England.)

THE CITY PLAN of University City, Mo., is described in detail in a report of the University City Plan Commission. The city is a suburb of St. Louis. A. P. Greensfelder, Merchants Laclede Building, St. Louis, is chairman of the commission.

STATICALLY INDETERMINATE BEAMS are analyzed by the theorems of two and three moments in Bulletin 64, Engineering Experiment Station, University of Washington, Seattle, Wash. The bulletin was prepared by Alfred L. Miller, associate professor of civil engineering. The theorem of three moments is employed in the revised form presented by the late Prof. I. P. Church. Illustrative examples are largely used throughout the bulletin. (Price 45c.)

CURRENT MOTOR-VEHICLE STATISTICS in great variety are given in a booklet published by the National Automobile Chamber of Commerce (366 Madison Ave., New York, N. Y.) entitled "Facts and Figures of the Automobile Industry, 1932 Edition." Such matters as motor-car and truck registrations, classified by states and as rural and urban, gasoline-tax receipts and disposition, summaries of state regulations, and highway financing, sources of income and expenditures will be found of value to students of highway economics. (Distribution free for single copies, 25c. for additional copies.)

LIGHT I-BEAMS were subjected to a series of strength tests conducted by the Engineering Experiment Station, University of Illinois, Urbana, Ill., in cooperation with Jones and Laughlin Steel Corp. The tests are reported in Bulletin No. 241 of the experiment station by Dean Milo S. Ketchum and Prof. J. O. Draffin. The beams tested were the recently developed J. & L. junior beams to which standard I-beam data are not applicable. By comparing the action of the light J. & L. junior beams with the strength of standard beams, as given in Bulletins 68 and 86 of the station, the authors of this bulletin state that it will be possible to draw conclusions for proper designs employing light I-beams. (Price 25c.)

PAVEMENT FINANCE AND TRAFFIC are the subjects of Bulletin No. 32, American Road Builders' Association (National Press Building, Washington, D. C.). The bulletin has been prepared by the city officials' division of the association. The section devoted to pavement finance cites specific instances of methods more generally employed in this country and gives the views of the committee that prepared it as to desirable methods. The section devoted to traffic (the major part of the 95-page bulletin) also approaches the subject by examples of means used to meet a wide variety of problems confronting traffic officers. One chapter of this section is devoted to an interpretation of the term "right-of-way."

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

COMBUSTION: Industrial Gas Series. Third edition, entirely rewritten. Paper; 9x12 in.; pp. 208; numerous figures and charts. Published by American Gas Association, 420 Lexington Ave., New York, N. Y. $2 plus postage.

DAS KRÄFTEPLAN-VERFAHREN—By J. D. Gedo. Paper; 7x9½ in.; pp. 184; 18 separate figures. Published by Alfred Kroner, Salomonstrasse 16, Leipzig, C-1, Germany. 12 marks.

DER BAUGRUND—By M. Singer. Cloth; 6x9 in.; pp. 393; numerous illustrations. Published by Julius Springer, 1 Schottengasse, 4, Wien (Vienna), Austria. 28 marks.

DER NEUZEITLICHE STRASSENBAU—By E. Neumann. Second edition. Cloth; 7x10 in.; pp. 474; numerous illustrations. Published by Julius Springer, Linkstrasse 23-24, Berlin, Germany. 35.50 marks.

MODERN SEWAGE TREATMENT—By T. P. Francis, engineer and surveyor, Dagenham Urban District Council, England. Cloth; 6x9½ in.; pp. 322; numerous illustrations. Published by The Contractors' Record, Ltd., 329 High Holborn, W.C. 1, London, England.

THE PORTS OF CHICAGO, CLEVELAND AND DULUTH-SUPERIOR: Lake Series No. 4 (Chicago), No. 5 (Cleveland) and No. 6 (Duluth-Superior)—Prepared by the Board of Engineers for Rivers and Harbors, U. S. Army, in cooperation with the Bureau of Operations, U. S. Shipping Board. Paper; 6x9 in.; many illustrations, including folding maps and tables. 50c., (Cleveland and Duluth-Superior), 60c., (Chicago), from Superintendent of Documents, Washington, D. C.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

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JULY 21, 1932 Volume 109 Number 3

Memorable Changes

FINAL adjustment and enactment of the relief bill and the home loan bank bill stamps the week as truly memorable. Both measures impress great changes on principles and relationships of long standing. The relief bill is the more immediate and sensational in its effects; some aspects of this many-sided law are discussed in another column. On a larger view, the establishment of mortgage discount banks, which we have supported since it was first actively urged more than a year ago by the National Association of Real Estate Boards, may prove to be quite as significant, for in providing a market for the easily frozen assets of real estate securities it lessens the burden of property ownership. Possibly mortgage interest rates will be lowered through its influence; at all events the peril of confiscation of savings will be lessened, and the nation's economic stability will be increased.

One Item of Progress

HOOVER DAM construction will not have to stop after all, for the inadequate six millions appropriated last spring in the Interior Department bill are supplemented by ten millions carried in the relief bill, just passed. The additional money provides for the cost of work to be done during fall and winter and gives practical assurance—so far as money can—that the river will be turned before the next flood season. A real calamity to Boulder City and the construction army encamped there is averted. Simultaneously comes the great penstock award, which calls for the most ambitious job of steel welding ever attempted. Its 50,000 tons of plate adds a weighty item to the starved steel market and puts a respectable item of business on the books of the railroads; some thousands of men will be at work for several years. The contract will thus contribute definitely to industrial revival. But it is even more important in relation to technical advance. Production of the 30-ft. pipes as well as their handling and placing will require the best resources of brains and field engineering available.

Better Prospects

OUR contemporary *The Business Week* reports that the economic world displays "a pattern of somewhat rosier color" than at any time within the past year or more. It sees better conditions at home and abroad, a sounder financial situation, constructive legislative achievement and healthier tone in the commodity and bond markets; business indicators have not yet risen perceptibly, but at least they show encouraging stability. These findings match the more confident general attitude toward industrial and business prospects that has developed since mid-year. Added reason for confidence is now given by the broad opportunities for initiative and new enterprise offered by the relief bill. The public-works loan clauses of the act clear the way for local governments, engineers and architects to mobilize every sound, self-sustaining project at their command, and the clause that extends aid to private business gives similar opportunity for industry to show its initiative. Means are thus made available for returning hundreds of thousands of workers to their jobs before snow flies, which in turn would exert a strong normalizing influence on business. On the outlook of the moment, therefore, better days are in prospect.

Necessary Reform

INCLUSION in the relief bill of the requirement that minimum wages are to be predetermined and published in the call for highway bids brings to pass tardily a needed reform. The present prevailing-wage law has not worked well, despite the Bourbon persistence of the Secretary of Labor in the belief that it does work. Confusion did arise, and was bound to arise, from the meaningless requirement that contractors must pay the prevailing rate of wages, the Secretary of Labor to pass on disputes when they arise. Minimum-wage rates named in the call for bids enable the contractor to bid with definite knowledge of the obligation he assumes. The highway proviso accordingly will make contracting more of a business and less of a gamble.

Unbusinesslike Practice

IT HAS long been a cardinal principle of good public business that every revenue-producing structure or service should stand on its own feet. In the light of the self-liquidating requirement of the relief bill, this principle acquires fresh honor. It means, first, adequate charges to cover the true costs, and second, conscientious application of the revenue to pay these costs. Both rules are disregarded with disappointing frequency by the federal government as well as by state and city governments. In every instance the effect of such disregard is to deceive both those who render the service and those who use it, and to create confused, fictitious balance sheets. No private business can long remain sound under such practice, and neither can a government. There are sometimes reasons for an apparent violation, as when a series of toll bridges is paid for out of joint revenues (as those of the Port of New York Authority), or when sewage-disposal charges are paid for out of water revenue, but in general the principle admits of no departure. This is one of the fundamental reasons against the growing evil of gasoline-tax diversion. In effect, it is deliberate falsification of the public accountbooks, and therefore unbusinesslike practice.

Coupling up Equipment

A NOTABLE example of recent invention in trains of equipment for accomplishing in succession a series of continuous construction operations is furnished by the two cable-laying plants described in this issue. In Germany and in America at the same time engineers have mechanized in virtually the same way the task of constructing long lines of underground electric transmission line. A coordinate development by the electrical industries has been the steel-tape-armored cable, which withstands rough handling in the field and can be placed directly in the ground without protecting conduits. Important as are the devices described to the industries that they directly serve, they possess greater significance as examples of a noticeable trend exhibited in roadbuilding, in placing concrete and in earth moving for performing in order and continuity the several operations required in a construction process. Equipment engineering today is displaying its greatest virility perhaps in the invention of equipment trains instead of equipment units.

The Relief Bill Is Enacted

THE Emergency Relief and Construction Act, which went on the statute books this week after a bitter struggle replete with sensational though trivial incidents, is in every respect the most momentous piece of legislation of the present era. Its transcendent importance for the emergency of the moment lies in its power to bring about vigorous revival of employment and in the immediate stimulation of construction that it will produce. But it has far-reaching social and financial implications beyond this. As the first definite attempt of the government to deal positively with unemployment, it marks out new courses in public policy.

Possibilities of epoch-making effects on the future reside in many provisions of the act, quite aside from the unprecedented charity-loan authorization. Among other things it establishes a new governmental policy on construction. It places the relation of federal and local governments on a new basis, which may lead to broader regulation and control. It sets up federal banking in competition with private banking. And it initiates government aid to mass housing. Future experience will have to show what these startling innovations imply.

The act represents a supreme effort of the nation to correct the human ills and distress arising from business breakdown. In this aspect it is a compromise between charity relief and public-works relief; the long contest between construction and dole ended in a draw. Back of this outcome lay the fact that through long neglect the need for relief had become so pressing as to demand immediate attention, while at the same time the progressive disappearance of construction was too obvious a factor in business disintegration to be ignored. There was sharp clash between divergent views as to how the economic upset might be rectified—between rock-ribbed conservatives who advocated a dole and liberals who held to self-recovery through employment; between those who approached the problem by way of the stock and bond market and those who thought in terms of human productive power. All parties were sincere, and compromise was inevitable. But it is nevertheless true that the government in substance has disclaimed responsibility for protecting its citizens from the undeserved hardships resulting from credit destruction; that issue remains to be fought out in the next depression.

Briefly, the act provides 300 millions for charity loans to the states, 1,500 millions for loans to promote local public works and housing, these two to be administered by the Reconstruction Finance Corporation; and 322 millions of Treasury funds for federal construction. Provision is also made for direct Federal Reserve loans to private business. The federal construction clause includes two items of very special importance to engineers: a 120 million dollar emergency highway loan fund, and 10 millions for Hoover Dam, which latter assures early turning of the river; these provisions, by preventing the paralysis of countrywide construction activities, will help powerfully to steady the course of business and will keep hundreds of thousands of men at work.

Outstanding features of the construction loan clauses are the wide discretion vested in the R.F.C. and the restriction of public-works loans to *self-liquidating* projects. As to the former, the whole effectiveness of the act may be said to hinge on the attitude taken by the corporation; if it looks on loans as the present-day banker does, little employment may result, but it will probably be distinctly more liberal. As to the self-liquidating restriction, a radically new principle is set up, of extensive future as well as present import.

Some of the forerunners of the act were based on the broad principle of creating public-works employment sufficient to restore earning power to those whom industry had discharged. These met fatal opposition at an early date. Later a more limited proposal was made, by this journal and by the American Society of Civil Engineers—namely, to restore the interrupted normal program of local construction. This also was disregarded, for the limitation to self-liquidating works excludes the major part of normal state and municipal construction. Yet it is estimated that, *if utilized effectively,* the act can put at least a million men to work.

"Self-liquidating" obviously implies that revenue shall be collected and shall be pledged against costs. This will make the act apply to toll bridges, benefit-assessment work, housing and occasional utility and special services. Apparently it covers waterworks and highways only when their revenues are expressly pledged. Through this restriction the act may have far-reaching effects on city accounting and revenue practices. Some proposals for segregation of revenue and imposition of special charges have in fact already been made. Earliest action is likely in respect to placing water-supply service on a self-contained basis.

Apprehensions have been entertained over the possible effect of the act to encourage municipal electric utility enterprise, and on the other hand it has been viewed as encouraging private sewage-disposal service. There appears to be little ground for such speculations. The act contains nothing tending to shift the fundamental line of demarcation between public and private enterprise.

In sum, the new law is of extraordinary importance in its bearing on employment, on construction and on business recovery. It is of great significance to city and state administration, to industry and to finance. While its full effects cannot yet be foreseen, an immediate large-scale revival of construction activity seems definitely assured.

In itself, of course, the law does little to create employment. What practical results it will achieve depend altogether on the energy, wisdom and speed of local governments—aided by their engineering groups, we trust—in developing their self-liquidating projects, obtaining loans for them and putting construction under way. Every project of the kind needs to be mobilized at once, for the country is ready to go to work.

NEWS OF THE WEEK

Power Commission Urges Control of Holding Companies

PUBLIC control of holding companies in the power utilities field is strongly advocated by the federal power commission in its report on holding-company control, soon to be issued. The commission recommends that the power of congress be invoked to effect such control.

During the past year the commission has conducted a study of holding companies as affecting the operation of licensees under its jurisdiction. In the introduction to its report, the commission states that it is convinced from this study and its administrative experiences that public control of holding companies in the power utility field is absolutely essential to the public interest. In its judgment such control to be adequate would include in its scope the service organizations of these holding companies, with supervision of all contracts between holding companies and their operating companies, and would include regulation of accounts, with requirements providing specifically for the filing of financial and other reports on prescribed forms with full publicity. Adequate public regulation would also include supervision of the issuance of securities to the investing public.

The commission believes that the best means of attaining public control may become better understood through the current congressional investigation directed to all holding companies, but the general proposition seems to have been already demonstrated that federal control of holding companies is absolutely essential to effective public regulation of the operating companies. The commission is convinced, therefore, that the power of Congress should be invoked to the fullest extent possible in the enactment of legislation to that end.

Analysis of the returns from a questionnaire shows that 48 major projects under license to public utilities are subject to control by ten top companies, and that these ten groups serve 12,487 communities with a population of more than 42,000,000. The report states that the degree of community of interest between the ten groups is indicated by the fact that 19 directors were directors or officers in the top company or a subsidiary company of at least two groups, one director being thus connected with four groups.

The data collected by the commission disclose the dominance of the holding company in that portion of the power field covered by projects licensed under the federal water power act.

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Port Authority Opposes 57th St. Bridge

Construction of the proposed Hudson River suspension bridge at 57th St., New York, is definitely opposed by the Port of New York Authority in a letter to the board of estimate and apportionment of the City of New York, made public July 18. It is contended that the project sponsored by the North River Bridge Co. of which Gustav Lindenthal is chief engineer would prove an actual obstruction to navigation, a serious menace to the city's new investment in long ocean steamship piers, a conflict with the bi-state program for interstate crossings, and that it also would not be economically justified. Tentative approval by the War Department of the application of the North River Bridge Co. prescribing a minimum clearance of 200 ft. at the center of the river and 185 ft. at the pierhead lines has been secured, but the issuance of a permit has been withheld, pending announcement of the views of the city authorities concerning the bridge.

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San Francisco to Vote on $6,500,000 Relief Bonds

An unemployment relief bond issue of $6,500,000 has been approved by the San Francisco board of supervisors and will be voted on at the primary election Aug. 30. The issue has the backing of city relief agencies and individuals in touch with charity who state that the 12,000 families now under care will be further increased by winter. Passage of the bond issue would permit elimination of the unemployment relief item from the present city budget. The bonds would run sixteen years at a rate determined by the bids, but not to exceed 6 per cent.

Municipal Costs for 1930 Increase Over Previous Year

According to a statement issued by the Bureau of the Census the aggregate expenditures of the 310 cities having a population of 30,000 or more were $3,810,682,000 in the fiscal year ended Dec. 31, 1930. Similar statistics for the previous year, issued by the bureau in 1931, included the expenditure figures for only 250 cities and showed aggregate payments of $3,435,290,000. On a per-capita basis, the cost of maintaining and operating the general departments of city governments (exclusive of public service enterprises) increased from $43.68 in 1929 to $44.53 in 1930.

The expenditures for the years 1929 and 1930 are compared in the following table:

	1930 (310 Cities)	1929 (250 Cities)
Operation and maintenance:		
General departments	**$2,112,199,000**	**$1,935,877,000**
Public service enterprises............	**178,110,000**	**166,657,000**
Interest on debt.......	**405,153,000**	**365,691,000**
Outlays for permanent improvements.....	**1,115,220,000**	**967,065,000**
Total.............	**$3,810,682,000**	**$3,435,290,000**

Statistics are available from 1903 for 146 cities, the number having more than 30,000 population in that year. For that group, the per-capita expenditures for maintenance and operation and interest on outstanding debt increased from $55.84 in 1929 to $57.69 in 1930.

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Passage of New Relief Bill Assures Expanded Employment

One-third billion dollars each for charity and federal public works and 1½ billions for loans to public bodies for self-liquidating projects now available from R.F.C. — Federal Reserve to administer private loans

IN THE closing days of the session, Congress made short work of passing a relief bill, discussion of which has occupied many months. The bill as passed excluded most of the features objected to by the President in the Wagner-Garner bill which he vetoed on July 11 (*ENR*, July 14, 1932, p. 58). The President has indicated his intention of signing the bill at an early date. Briefly, it provides $300,000,000 for charity loans to the states, $322,224,000 for federal public works including $120,000,000 for federal-aid highways and $10,000,000 for Hoover Dam and $1,500,000,000 for loans to public bodies against self-liquidating projects, which are defined. The $2,122,224,000 provided by the bill will be administered for the most part by the Reconstruction Finance Corporation. In addition to these direct means of stimulating employment, the relief bill includes an amendment to the Federal Reserve Act, authorizing the Federal Reserve Board to authorize Reserve banks to make loans direct to individuals or corporations by discounting notes, drafts and bills of exchange. In effect, the Reconstruction Finance Corporation is the agency of public relief administration while the Federal Reserve will administer all private relief loans.

Charity Loans

The fund of $300,000,000 set up for temporary charity loans is available to such states as are unable to finance the relief work resulting from unemployment. It is stipulated that not more than 15 per cent of this amount is available to any one state. All such loans will bear interest at 3 per cent and will be repaid by making annual deductions from regular federal-aid highway loans to the states. It is contemplated that one-fifth of the share which the borrowing state would be entitled to will be withheld for five years beginning in 1935.

Loans on Self-Liquidating Projects

One of the most important features of the bill and the one involving by far the largest amount of funds relates to loans by the Reconstruction Finance Corporation to states, municipalities, and public agencies and corporations of various kinds to aid in financing projects which are self-liquidating in character. According to the bill, a project is self-liquidating "if such project will be made self-supporting and financially solvent and if the construction cost thereof will be returned within a reasonable period by means of tolls, fees, rent or other charges, or by such other means (other than by taxation) as may be prescribed by the statutes which provide for the project." Several types of self-liquidating projects are specifically mentioned. Thus the Reconstruction Finance Corporation is empowered to make loans to corporations formed for the purpose of providing housing for families of low income or for reconstruction of slum areas, provided these are regulated by state or municipal laws as to rents, charges, etc.; to make loans to private corporations to aid in carrying out construction, replacement or improvement of bridges, tunnels, docks, viaducts, waterworks, canals and markets devoted to public use; to make loans to private limited-dividend corporations to aid in financing projects for the protection and development of forests and other renewable natural resources; to make loans to aid in financing construction of any publicly-owned bridge, the construction cost of which will be returned in part by means of tolls, the remainder by state taxes.

Funds for these projects will be made available by the Reconstruction Finance Corporation purchasing securities issued against the projects.

The bill also stipulates that no convict labor shall be directly employed on any of these projects and working hours shall be limited to thirty in any one week.

Direct Loans by Federal Reserve

An amendment to the Federal Reserve Act contained in the new relief bill provides that "for a period of two years in unusual and exigent circumstances" the Federal Reserve Board may authorize any Federal Reserve bank to discount for any individual or corporation notes, drafts and bills of exchange which are now eligible for discount for member banks. This is the only provision for strictly private loans in the relief bill, as finally passed.

Public Works

A total of $322,224,000 is made available for the purpose of providing for emergency construction of certain public works "with a view to increasing employment." This money is to be obtained from unappropriated funds in the Treasury, so that in contrast to the other funds in the bill, it involves federal tax revenues. This public works appropriation is broken down in the bill into $120,000,000 for federal-aid highways, $10,000,000 for national forest highways, trails, bridges, etc., $3,000,000 for roads and bridges in the national parks, $1,000,000 for roads in Indian reservations, $2,000,000 for roads in unappropriated or unreserved public land, $30,000,000 for river and harbor work, $15,500,000 for previously authorized flood control projects, $10,000,000 for continuation of construction at Hoover Dam, $500,000 for air navigation facilities of the Department of Commerce, $1,250,000 for engineering work of the Coast and Geodetic Survey, $10,000,000 for the Navy Department, bureau of yards and docks, to be used on projects included in the report of the Federal Employment Stabilization Board, $100,000,000 for the construction of public buildings outside the District of Columbia, $15,000,000 for construction at military posts and $4,000,000 for the lighthouse service and for establishing and improving aids to navigation and other works approved by the Secretary of Commerce.

Highway Appropriation

The federal-aid highway appropriation of $120,000,000 is a temporary advance of funds. It is contemplated that loans from this fund may be used by the states to match the regular annual federal-aid appropriations. It is provided that the money shall be repaid to the federal government over a period of ten years commencing with 1938, by making annual deductions from future regular authorizations.

It is specifically noted that all contracts involving expenditure of these funds shall contain provisions establishing minimum rates of wages, to be predetermined by the state highway departments. These minimum rates are to be stated in the invitation for bids and included in the bids. The recent bill also amends the federal highway act to permit the use of the funds for highway and bridge construction within municipalities and removes the limitation upon the amount available per mile.

The public buildings, for which $100,000,000 is appropriated, are to be selected by the Secretary of the Treasury and the Postmaster General from the public building projects already listed. Preference is to be given to places where government facilities are now housed in rented buildings under leases which will expire on or before July 1, 1934, or which may be terminated on or before that date.

Administration of Loans

While the individual directors of the Reconstruction Finance Corporation have given some thought to the problems of organization which must be undertaken as a result of the increased scope of the organization, the board, at the time of this writing, had had no opportunity to discuss the matter. Pending business under the original act has been so heavy as to preclude any consideration of the relief act. Members of the Corporation's staff are preparing tentative forms to cover applications under the new act, and the legal division is attempting to work out an interpretation of the "self-liquidating" definition, as applied to engineering projects.

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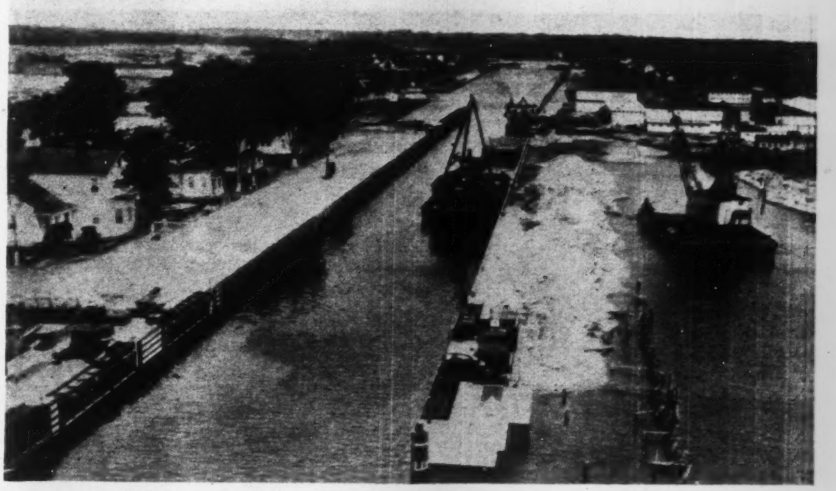
Bills for Local Tax Relief Considered by Indiana Legislature

Bills providing for tax relief through consolidations of townships and counties, and for returning a larger share of state funds for local highway use have been introduced into the special session of the Indiana legislature.

The machinery to effect consolidation is provided for in bills introduced in the senate. From petition of 60 freeholders in each county there must be held a referendum on consolidation and the decision of the majority carried out. For the merger of townships, three methods are provided. One is by motion of county commissioners, another by freeholders petitioning the commissioners and the third by referendum brought about by 25 freeholders petitioning for it.

Bills introduced into both houses call for splitting funds derived from automobile license fees and the state gasoline tax equally between the state and local governments. At present license fees amount to about $6,000,000 and the gas tax to $12,500,000 annually. Division of the half reserved to local units would be 50 per cent to counties as such, nine-tenths of the remainder to counties on the basis of improved mileage and the other tenth to cities and towns on a population basis.



NEW VIRGINIA LOCK PRESERVES FEEDING GROUND FOR GAME

The new million-dollar tidal lock of the Albemarle & Chesapeake Canal at Great Bridge, Va., prevents salt water from passing from tidal areas into the fresh waters of Currituck Sound in North Carolina and the Back and North Bay region of Virginia. The mixture of salt water and pollution from Norfolk Harbor destroyed countless acres of feeding grasses visited annually by migratory birds. The salt water also affected the game fish in the area. Construction of the tidal lock was brought about through the agitation of sportsmen.

Construction Compensation Rates Boosted in Ohio

Effective July 1, nearly all classes of construction compensation insurance rates were increased by the Ohio Industrial Commission. Rates on general building construction, with the exception of steelworkers, have been increased from $3 to $4 per $100 payroll. Steelworkers rates jumped from $13 to $15. Residence construction rates increased from $1.80 to $2.20. Rates on carpenters on form work were raised from $3 to $3.50. The increase on street and road workers was $1, now being $5. Other increases were: cement gun workers, $4 to $5; concrete bridge laborers, $7 to $9; plumbers, $1.10 to $1.20; masons on buildings, $4.50 to $6.

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Seek to Remove Gas Main at Damaged Ohio Office Building

The Columbus Gas & Fuel Co. has applied for an injunction to restrain the state of Ohio from interfering with the removal of the gas pipe fronting the new state office building. A hearing on the injunction was held on July 14 and the company's application has been taken under advisement.

Following closely on the report by the attorney-general to the State Office Building Commission that the recent explosion that occurred was caused by a leaky gas main, damage suits totalling several hundred thousand dollars were filed against the company by men injured in the explosion. The state has asked that the gas pipe in front of the building be impounded, while the legal representatives of the gas company maintain that the pipe is needed for analyses in connection with the damage suits.

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Concrete Pavement Yardage

There is given below a tabulation of concrete pavement yardage awarded in the United States during the month of June, divided according to roads, streets and alleys, and the total for the first six months ending July 2, 1932.

	Yardage Awarded During June, 1932	Total Yardage Awarded to July 2, 1932
Roads	10,038,405	40,439,971
Streets	948,412	3,662,123
Alleys	81,389	197,873
Total	11,068,206	44,299,967

FIRST FLOOD TO PASS OVER THE NEW DAM AT DNIEPROSTROY

On May 6 a flood of 500,000 sec.-ft. was passed over the spillway of the Dnieper River Dam of the Dnieprostroy hydroelectric project in Russia. It was the first spring flood since the completion of the dam. In May, 1931, a flood of 835,000 sec.-ft. was passed through the partly completed structure. The dam is founded on solid rock and the spillway has a short bucket which is submerged even at low water. The character of the hydraulic jump developed is clearly shown in the photograph. Details of the dam were given in *ENR*, June 23, 1932, p. 877.

Home Loan Bill Passed to Release Frozen Real Estate Credits

THE federal home loan bank bill, with a national bank-currency expansion program attached, was passed on July 16 and sent to President Hoover for his signature. Since the plan was one of the President's proposals for economic rehabilitation, its approval has been forecast.

The legislation creates a new and independent system of banks, with a capital of $125,000,000 to furnish financial aid to home owners through rediscount of home-loan mortgages held by various types of corporations. In the words of the bill the term home mortgage means "a first mortgage upon real estate in fee simple, or leasehold under a renewable lease for not less than 99 years, upon which there is located a dwelling for not more than three families." The system will include a minimum of eight and a maximum of twelve federal home-loan banks with a federal home loan bank board of three members in Washington to supervise the bank activities after the manner in which the Federal Reserve Board operates.

It is provided that the Treasury will acquire all of the $125,000,000 of the capital stock at the outset. Borrowing institutions may qualify for that privilege by becoming members of the bank in their jurisdiction, such qualification requiring that they subscribe to stated amounts of the capital stock.

Attached to the bill in the form of an amendment is a measure that bestows the circulation privilege for a period of three years on treasury and government bonds that bear 3⅜ per cent interest or less, which it is estimated can result in an expansion of the national bank note circulation by $995,000,000.

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River and Harbor Allotments Announced by War Department

Of the sixty million dollars included in the War Department appropriation act passed on July 14, for river and harbor work, the initial allotment totaling $42,315,392 has been made by the Secretary of War on the recommendation of the Chief of Engineers to provide funds necessary to meet immediate requirements. The balance of the appropriation will be allotted later when bids for contemplated work shall have been received and the amount required definitely determined. Specific improvement projects total 182, excluding the allotment for examination, surveys and contingencies of various districts. Among the larger allotments are:

Delaware river, Philadelphia to the sea	$1,741,000
Caloosahatchee river and Lake Okeechobee drainage area, Florida	2,133,000
Ohio river	2,231,000
Kanawha river, W. Va.	1,030,000
Mississippi river, Illinois river to Minneapolis	3,370,000
Mississippi river, Ohio river to Illinois river	2,257,000
Missouri river, Kansas City to the mouth	5,410,000
Missouri river, Kansas City to Sioux City	750,000
Illinois river	4,188,000
St. Marys river, Mich	1,601,000
Detroit river, Mich	1,068,000

New $3,000,000 Bridge Opened in British Columbia

Burrard Bridge, spanning False Creek inlet and connecting the business section of Vancouver with the residential area on Point Grey, was formally opened on July 1. The new bridge was built at a cost of $3,000,000. A central span, 315 ft. long, allows a clearance for navigation of 90 ft. at high tide, and is supported by two piers, each 200 ft. high and 41½x102 ft. at the base. The roadway of the bridge is 60 ft. wide, providing for six traffic lanes, three in each direction, and two nine-foot sidewalks. The total length of the bridge is about 2,900 ft. The plans provide for the addition of a lower deck to carry railway and street car tracks. This part of the bridge, it is estimated, would cost approximately $750,000.

◆

Denver Reduces Water Rates

Flat rates charged for water by the Denver Board of Water Commissioners will be reduced on Aug. 1 to the schedule in effect before the 1928 20 per cent increase. Most domestic water consumers in Denver are on a flat rate basis. Meter rates which were increased 25 per cent in 1928 are to be reduced 10 per cent. Irrigation rates are to be reduced 20 per cent.

These reductions, amounting to $450,000 per year, are considered only temporary and emergency measures. They were recommended by the Allied Improvement Association, Real Estate Exchange, Colorado Society of Engineers and other organizations even though in half of the letters received from individual consumers the opinion was expressed that the existing rates should be retained. The organizations recommended the emergency reduction not so much on the merits of the work the water department is doing with its revenue but because of the general popular demand to cut expenses.

Work on the Eleven Mile Canyon Dam has not been stopped and will be completed this fall.

◆

Court Finds Leaky Sewer Not Fault of Contractor

Excess leakage in the Aberjona Valley sewer, built for the city of Woburn, Mass., by James J. Coughlan & Sons, Inc., of Boston, is not the fault of the contractor according to a decision made by Judge Louis L. Green sitting as auditor appointed by the Middlesex superior court to try nine suits brought by the city against the contractors and consulting engineers. The Coughlan Co. was awarded $8,441 as sixth and final payment due them for construction of the sewer in 1927. The suit involved the responsibility on the part of the contractor wherein he did not furnish the material nor had he any choice in the material furnished. The Coughlan Co. was awarded the contract under specifications calling for furnishing of either vitrified pipe or vitrified segment blocks by the city. The city chose to furnish the segments, and the contract was performed to the full satisfaction of the engineers. After the sewer was completed, excessive leakage developed and the city withheld final payment pending a suit for damages. The court held that the type of construction was unsuited to sanitary sewers in unusually wet ground, but that the contractor followed plans and specifications and used the materials furnished him and was therefore not responsible for the performance of the completed sewer.

◆

Highway Work in Wayne County Provides Employment for 4,600

Four thousand six hundred heads of large families have received nearly $2,000,000 since October from the Wayne County (Michigan) road commission for work on viaducts, bridges, roads, parkways, and a two-mile sea wall. Employment has been limited to men having six or more dependents. The highway commission has presented its employment record as a reply to the arguments that were made last fall against the half-mill tax for county road purposes.

The construction forces were recruited from the lists of the welfare department, from which the men had been receiving $12 per week. The shifts were so arranged that each man worked 55 hours every other week. At winter peak the county had 2,300 men at work each week, providing actual employment for 4,600 men. Available money is now running low, and there are only 1,400 men employed at present.

The work completed includes concrete highways, a new bridge in Wyandotte, a two-mile sea wall at Grosse Pointe Farms, and several grade separations.

◆

Construction of Texas Railroad Opposed by Examiner

The recommendation that the Interstate Commerce Commission refuse to permit the Del Rio and Northern Railway to construct 132 miles of new railroad in Texas from Sonora through Del Rio to Quemado was made July 14 by examiner O. D. Weed.

The examiner stated that Del Rio and Eagle Pass and the districts surrounding those towns are now served by the Southern Pacific Railroad and the service seems to be generally satisfactory. The existing industrial and agricultural conditions indicate little need for increased production of farm crops and it is the belief of the examiner that the applicant's estimate of traffic and revenue are too optimistic. Further, the examiner stated, any extension of railroad mileage in this territory could be constructed more economically by the Southern Pacific. That carrier indicates its readiness to build such mileage as soon as needed.

◆

Anderson Water Department to Be Investigated by State

Upon petition presented by 14 industrial plants in the city of Anderson, Ind., the state public service commission has ordered an investigation of the business affairs and quality of service of the municipal water plant. The petition alleges that the water is unfit for drinking and that the business of the plant is improperly conducted.

Ten-Year Contract for Refuse Disposal Let by Baltimore

BALTIMORE, MD., has awarded to the E. T. Foreman Co., of Baltimore, the contract for the construction of a garbage and rubbish incinerating plant, the operation of the plant for ten years and the collection of rubbish for five years. The award of the contract was made after the court had dismissed a suit for an injunction to restrain the city from awarding the contract and building the plant.

Objections to the award of the contract came from two groups. Business men and property owners in the neighborhood of the proposed plant objected to the concentration of the city's garbage at one point until further facilities for incineration can be constructed elsewhere. The commission of efficiency and economy, a governmental research body, objected to the private-contract features of the proposed plan, advocating instead complete municipal operation.

As described in *Engineering News-Record*, June 2, 1932, p. 804, the specifications call for the collection of rubbish for five years, the incineration of rubbish for ten years, and the incineration of garbage for ten years. The incineration plant is to be built by the contractor and is to be turned over to the city at the expiration of the contract.

Bids were opened on June 15. The Foreman Co. bid $4.10 per ton for collection and hauling of rubbish; 80c. per ton for incineration of rubbish; $1.85 per ton for incineration of garbage. Over a five-year period the cost to the city for collecting and hauling rubbish would be $2,460,000, based on an estimated annual collection of 120,000 tons; for ten years the cost of rubbish incineration will be $352,000, based on an estimated annual tonnage of 44,000; and $1,480,000 for incineration of an estimated annual garbage tonnage of 80,000. The total bid for the life of the contract was $4,292,000.

It has been announced that plans for the plant will be prepared immediately and that the incinerator will be ready for operation on Jan. 1, 1933.

◆

Lack of Funds Causes Shutdown of Abitibi Power Project

Work on the hydro-electric project at Abitibi Canyon in Ontario has been closed down. The construction of the power development has been under way by the Ontario Power Service Corporation, a subsidiary of the Abitibi Power and Paper Company. That company has had difficulty in raising money to continue the construction work and has recently been unable to meet the interest requirements on its outstanding bonds.

Plans have been made by the Ontario government to take over the development but it has declined to guarantee to the Dominion Construction Company, contractors on the work, that the government would pay for any work done during the period in which the Ontario Power Service Corporation was still owner.

Brief News

A **Portrait of Mansfield Merriman** was recently presented to Lehigh University by the members of the Class of 1897. Dr. Merriman was Lehigh's first professor of civil engineering and was serving continuously in that position from 1878 to 1907.

A **Ton-Mile Tax** on motor trucks operating over highways in California as a substitute for the present gross-revenue tax has been recommended to the State Railroad Commission by the Certified Motor Truck Carriers. Daily reports of trucks operated would be necessary. The tax would be divided between the state and county road departments.

Research Into Pavement Slipperyness is to be made in Ohio by a committee recently appointed by O. W. Merrell, director of highways. Harry T. Flashern, maintenance engineer, Ashland, Ohio, is chairman of the committee. The committee will extend its study into other states to secure information from highway departments on methods employed for the elimination of slippery pavement conditions.

◆

Personal Notes

Frank P. Fifer has returned to Baltimore, Md., after six years spent on the Dnieprostroy hydro-electric project in Russia.

John R. Nichols and **Charles E. Nichols**, formerly with Stone & Webster Engineering Corp., are now associated as consulting structural engineers with offices in Boston, Mass.

H. C. **Parmelee**, editorial director of the McGraw-Hill Publishing Company, has been appointed a member of the National Research Council, of the division of engineering and industrial research.

◆

Obituary

Joseph F. Sargent, of St. Louis, Mo., was killed instantly on July 15 when a box of dynamite exploded while he was opening it. Mr. Sargent had the contract to build a section of state highway just north of LaGrange, Mo., and was within four days of completing the contract.

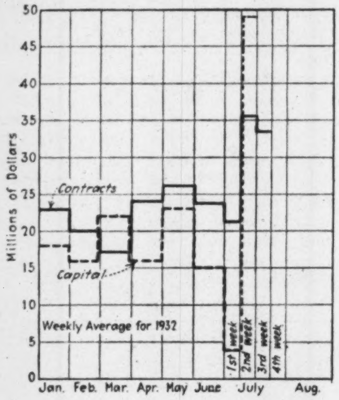
Ray Fowler Otis, city engineer of Batavia, New York, died of a heart attack on July 11. Mr. Otis became assistant city engineer of Batavia in 1922 and was named city engineer three years later. He was born in Yonkers, N. Y., but had lived in Batavia since 1893.

Thomas H. Alison, president of the Bergen Point Iron Works, died at his home in Bayonne, N. J., on July 16. He was 60 years old. Mr. Alison was graduated from the engineering school of the University of Toronto, after which he was connected with the Dominion Bridge Co. and with the Trenton Iron Works. Since 1896 he had been associated with the late Augustus Smith, who preceded him as president of the Bergen Point Iron Works, in engineering projects, including lighthouses, recreation piers, sugar mills and coaling stations.

Engineering Contracts and Capital

Heavy engineering construction contracts reported for the week total $33,386,000, making the average weekly total for July $30,393,000, as compared with $23,207,000 for June and $49,022,000 for July, 1931. For the first time since the week of March 17 private contracts exceeded public awards. Two powerhouse contracts totalling $14,000,000 brought private work for the week up to $18,331,000. Public contracts amounted to $15,055,000. Highway lettings for the week reached $7,261,000, about half that of the previous week.

New productive bond issues for the week were the heaviest yet this year, totalling 49 millions. Of this amount 41 millions was for utilities, being the first private issues reported for some months.



Building Permits Slump—Building permits, as reported by S. W. Straus & Co., continued to decline during the month of June. Reports from 583 cities show permits for the month total $38,415,000, a loss of 12 per cent from the May total as reported by Straus and a decline of 63 per cent from the June figures of 1931.

Steelworkers Face Wage Cut—New Jersey ironworkers and hoisting engineers will take a wage cut of $2, from $16 to $14, effective Aug. 1, according to an order by the Associated Contractors of New Jersey. The new scale will still be 80c. higher than that accepted by similar trades in New York City recently.

Tax Outside Workers—Aimed to provide protection to Montreal residents, the city council has passed a resolution asking for legislative authority to tax every person working in Montreal and paying no tax to the city.

Buffalo Relief Work—Temporary work for 2,500 is provided by an appropriation of $400,000 made by the city of Buffalo. The entire amount will be used for labor on highway and park jobs to be created.

Hand Labor Permitted on Roads—The substitution of hand labor and teams for machinery will be permitted on federal aid highway projects in Utah, providing the cost is not increased materially, according to a statement made by Thomas H. MacDonald to the Salt Lake *Tribune*.

Contracts and Capital

CONSTRUCTION
(Thousands of Dollars)

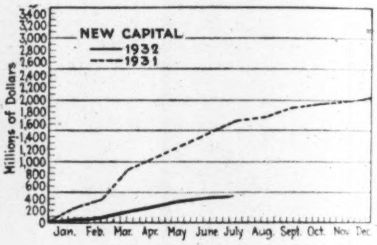
	Weekly Average July 1931	Weekly Average July 1932	Week July 21 1932
Federal government...	$4,512	$10,351	$4,932
State and municipal...	25,245	11,360	10,123
Total public........	$29,757	$21,711	$15,055
Total private.......	19,265	8,682	18,331
Week's total.......	$49,022	$30,393	$33,386
Cumulative, Jan. 1 to date:			
1931 construction..................			$1,688,878
1932 construction..................			689,708

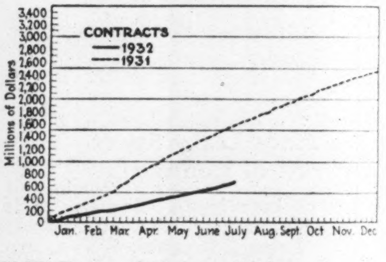
Decrease, 59 per cent.

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Weekly Average July, 1931	Weekly Average July, 1932	Week July 16, 1932
Total private and public	$41,500	$26,500	$48,700
Cumulative, Jan. 1 to date			
1931 new capital..................			$1,548,000
1932 new capital..................			488,000

Decrease, 69 per cent.





ENR Cost and Volume Index

Cost		Volume	
July, 1932......	**153.36**	**June, 1932......**	131
June, 1932......	152.20	May, 1932.......	149
July, 1931.......	174.37	June, 1931.......	243
1931 (Average)..	181.35	1931 (Average)...	220
1930 (Average)..	202.85	1930 (Average)...	260

1913 Average........ 100.00

SOCIETY CALENDAR

NEW ENGLAND WATER WORKS ASSOCIATION, annual meeting, Springfield, Mass., September 27-30.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., October 24-27.

AMERICAN ASSOCIATION OF ENGINEERS will hold its 18th Annual Convention at the Shoreham Hotel in Washington, D. C., on September 26 to 28. The Clausen Gold Medal will be awarded at the annual banquet on September 28.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION held its annual convention at Oregon State College, Corvallis, Oregon, early this month. R. A. Seaton, dean of engineering, Kansas State College, was elected president for the ensuing year.
The Lamme Medal was awarded to A. N. Talbot, professor emeritus of municipal and sanitary engineering at the University of Illinois.